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A SYSTEMATIC INTERPRETATION OF A DOSAGE-EFFECT RELATIONSHIP FOR THE PREVALENCE OF NOISE-INDUCED ANNOYANCE

Sanford Fidell
David M. Green

BBN Systems and Technologies Corporation
21120 Vanowen Street
Canoga Park CA 91303

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Air Force Systems Command
Brooks Air Force Base, TX 78235-5000

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ROBERT C KULL, JR, Capt, USAF
NSBIT Program Manager

FOR THE COMMANDER

MICHAEL G MACNAUGHTON, Col, USAF
Program Director
Human Systems

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This report applies a NSBIT-developed probabilistic model to a body of social survey findings described by Fidell, Barber and Schultz (1988) to derive a dosage-effect relationship between outdoor noise exposure and the prevalence of annoyance in communities. The probabilistic model (Fidell, Schultz and Green, 1988) provides a means for independently estimating the contributions of acoustic and nonacoustic factors (the latter collectively termed "response bias") to the observed prevalence of annoyance in communities.

The results of the analysis described in this report permit construction of tools that environmental planners can use to make more sophisticated and defensible predictions of annoyance associated with noise of Air Force flight operations.

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22b. TELEPHONE *(Include Area Code)*
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Foreword

This report was prepared under Contract F33615-86-C-0530 of the Noise and Sonic Boom Impact Technology (NSBIT) program. The NSBIT program is conducted by the United States Air Force Systems Command, Human Systems Division under the direction Captain Robert Kull, Program Manager. Mr. Lawrence Finegold served as the contract monitor for this effort.

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Executive Summary

This report applies a probabilistic model of the prevalence of noise-induced annoyance to a body of social survey findings to derive a dosage-effect relationship between outdoor noise exposure and the prevalence of annoyance in communities. The probabilistic model provides a means for independently estimating the contributions of acoustic and nonacoustic factors (the latter collectively termed "response bias") to the observed prevalence of annoyance in communities.

The results of the analyses described in this report permit construction of tools that environmental planners can use to make more sophisticated and defensible predictions of annoyance associated with the noise of Air Force flight operations.

1. Introduction

Environmental planners and others interested in predicting community response to general transportation noise have relied for a decade upon a relationship often referred to as the "Schultz curve" (because it was developed by Schultz in 1978) as the best available source of empirical dosage-effect information. This relationship between outdoor noise exposure and the prevalence of annoyance in communities has been an invaluable aid in assessing community response to noise exposure, simply because it has provided environmental planners with a straightforward summary of the findings of a number of social surveys. The Schultz curve, reproduced in Figure 1-1, is a third-order polynomial approximation to a set of data points:

$$\%HA = 0.8553 L_{dn} - 0.0401 L_{dn}^2 + 0.00047 L_{dn}^3 \qquad (1\text{-}1)$$

where %HA is the percentage of attitudinal survey respondents reporting high annoyance due to noise exposure, and L_{dn} is the symbolic representation of the Day Night Average Sound Level (abbreviated DNL), a metric of community noise exposure.

Schultz preferred a polynomial approximation to the data points on which the 1978 curve was based to a least squares fit, in part to force the curve to zero prevalence of annoyance at an exposure level of L_{dn} = 45 dB. The decision to force the curve to zero at L_{dn} = 45 dB was made for the sake of consistency with the determination of the Environmental Protection Agency (EPA, 1974) that noise exposure at this level produces no adverse effects on public health or welfare.

The data set from which Schultz developed the 1978 dosage-effect relationship contained 161 points. Fidell, Barber, and Schultz (1989) recently added 292 points to the data set, as shown in Figure 1-2. The equation for the curvilinear (quadratic) regression to the 453 data points shown in Figure 1-2 is:

$$\%HA = .0360 L_{dn}^2 - 3.2701 L_{dn} + 79.1393 \qquad (1\text{-}2)$$

The quadratic least squares fit accounts for 45.5% of the variance in the data points.

Heated debate (cf. Kryter, 1982) over explanations for scatter in the 161 data points considered by Schultz (1978) has focused on issues such as bias errors in estimation of both independent and dependent variables, and on source specificity. The latter issue is of particular concern to Air Force environmental planners, since it has been argued that different dosage-effect relationships should be used to predict annoyance due to different community noise sources. In particular, some believe that a relationship used to predict reaction to aircraft noise should predict greater annoyance for a given level of noise exposure than a relationship for other transportation noise sources.

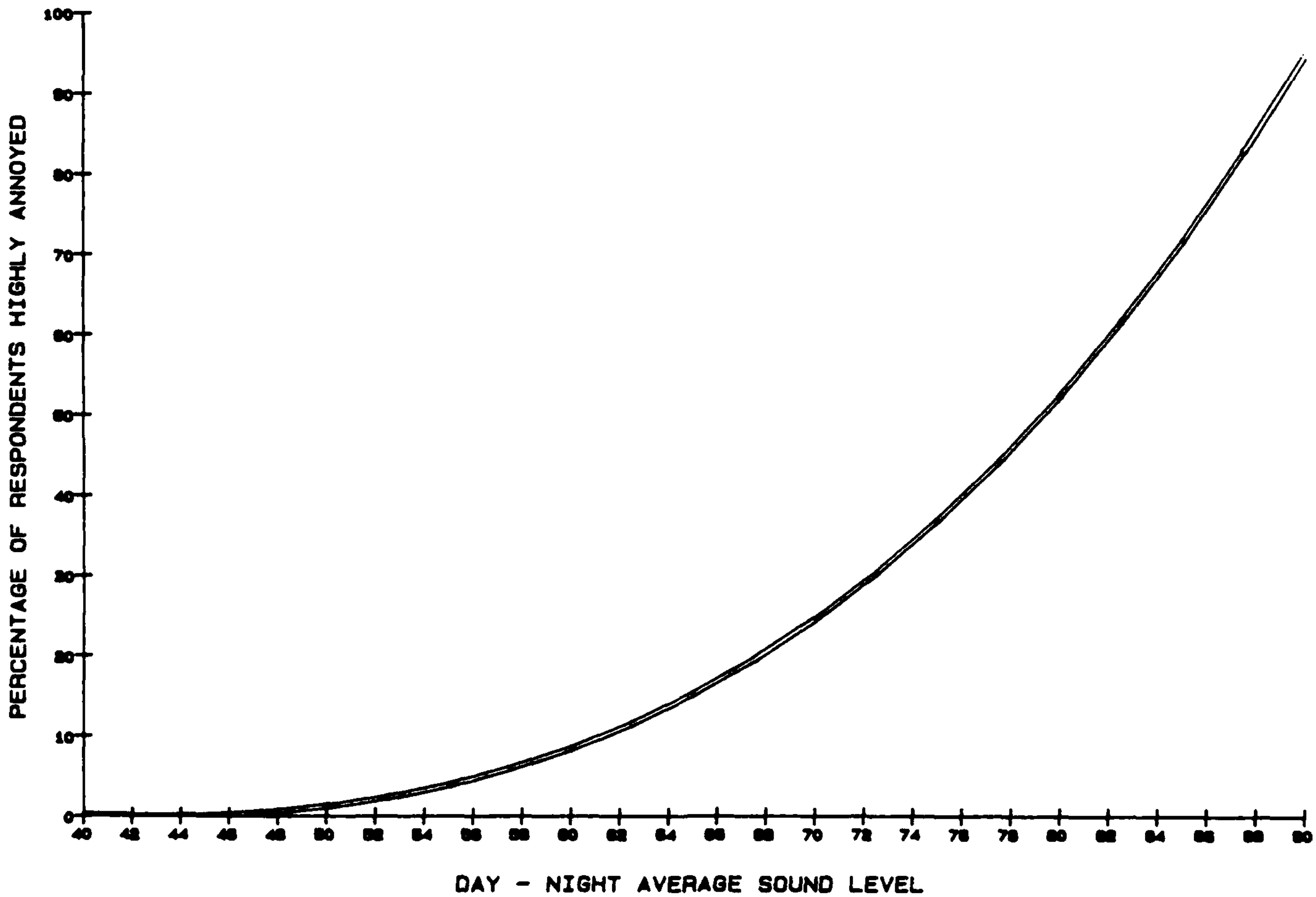

Figure 1-1: Dosage-Effect Relationship Derived by Schultz (1978).

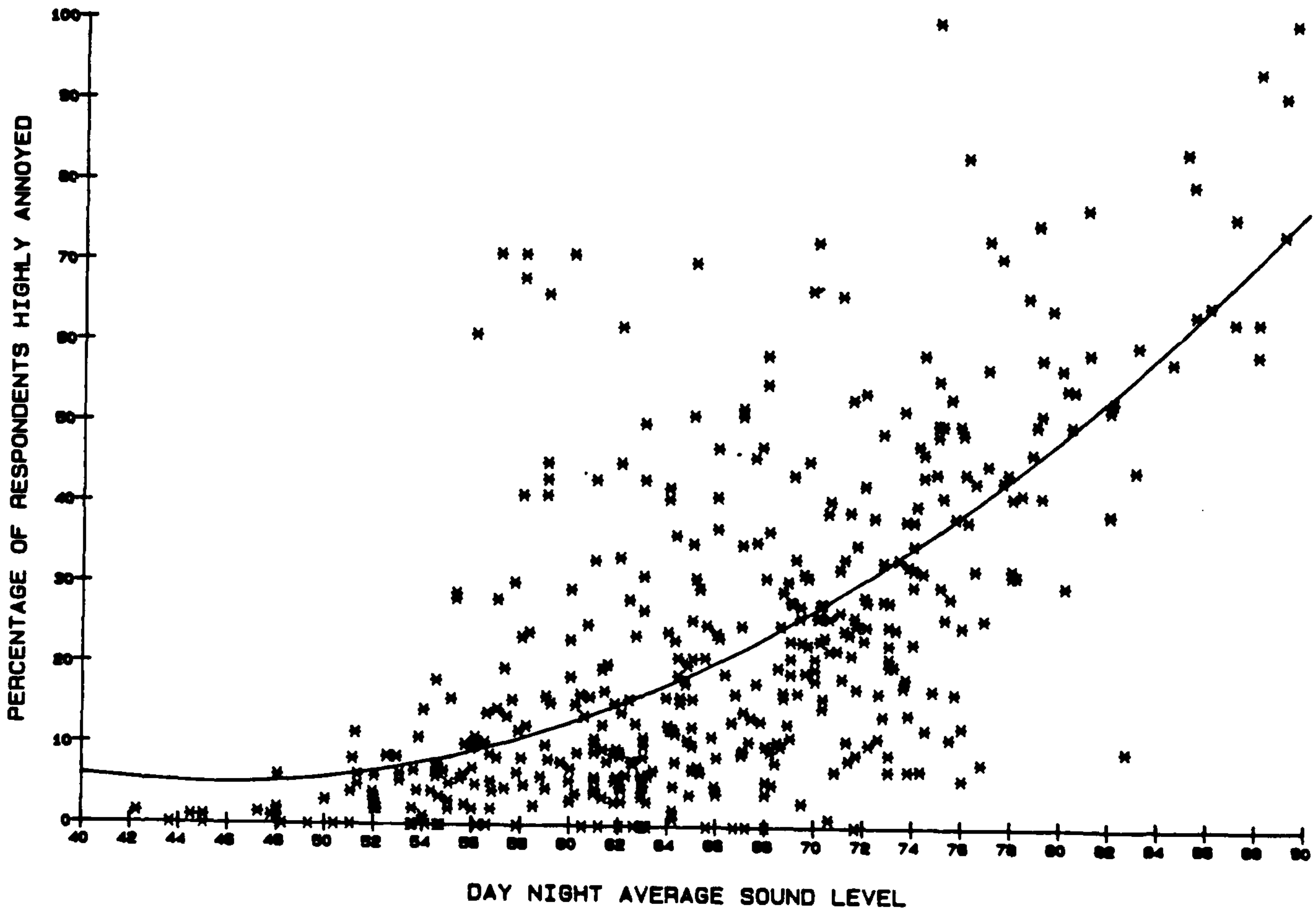

Figure 1-2: Updated Dosage-Effect Relationship (Fidell, Barber and Schultz, 1989).

Although the 1978 dosage-effect relationship is well documented and widely accepted, and although it has recently been updated, its utility for predictive purposes is constrained by its purely empirical nature. As noted by Fidell and Green (1988), the mere existence of a dosage-effect relationship does not provide answers to fundamental questions about the nature of annoyance such as the following:

- How adequately can the prevalence of annoyance be predicted from knowledge of noise exposure levels alone?
- Can the prevalence of annoyance be more accurately predicted by accounting for the influences of nonacoustic factors on self-reported annoyance?
- Why can 2 communities exposed to the same aircraft noise differ greatly in the prevalence of annoyance?
- Decibel for decibel, is exposure to aircraft noise more annoying than exposure produced by other community sources?
- What are the relative magnitudes of the contributions of acoustic and nonacoustic factors to the prevalence of annoyance in a community?
- How can the effects of local circumstances be accounted for in predicting the prevalence of annoyance?
- What confidence intervals can be placed on Air Force predictions of the prevalence of annoyance?
- What factors contribute in what degree to the sizes of such confidence intervals?

Fidell, Schultz and Green (1988) also note that the lack of systematic understanding of noise-induced annoyance and of theory-based, quantitative prediction models creates a variety of problems for the Air Force:

- The Air Force has encountered difficulty persuading those who review its environmental impact assessment documents that it is in fact using the best available technology for predicting the prevalence of annoyance;
- The Air Force has difficulty defending its reliance on an empirical dosage-effect relationship for prediction of the prevalence of annoyance in the face of seemingly reasonable alternative means of predicting annoyance;
- The Air Force has no logical means for extending its predictions of the prevalence of annoyance beyond the circumstances under which the data of the empirical dosage-effect relationships were taken;
- The Air Force has difficulty supplying cogent replies to questions about the effects of various nonacoustic factors on the prevalence and intensity of annoyance;
- The Air Force cannot supply easily understandable explanations for discrepancies between its predictions of the prevalence of annoyance and the apparently greater prevalence of annoyance sometimes expressed in overflown communities;
- The Air Force cannot readily quantify errors of prediction of the prevalence of annoyance;
- The Air Force has no way of replying to the testimony of those who claim that annoyance is far greater than the Air Force predicts without seemingly attacking their integrity; and

- The Air Force has no persuasive means of documenting that unexpectedly vigorous community reaction may be attributable to factors other than physical noise exposure.

This report provides a systematic, theory-based interpretation of an updated dosage-effect relationship between noise exposure and the prevalence of annoyance in communities. Computer-based tools for performing these analyses will permit environmental planners to make more sophisticated and defensible predictions of the prevalence of annoyance in communities exposed to noise from Air Force flight operations.

Chapter 2 contains background information about the nature of reports of annoyance associated with aircraft noise exposure. Chapter 3 derives relationships needed to partition reported annoyance into 2 components, and to estimate the relative contributions of the 2 components to the observed prevalence of annoyance in communities. The chapter then applies these relationships to the data of attitudinal surveys on the prevalence of noise-induced annoyance and evaluates the results. Chapter 4 discusses some of the implications of these analyses, and Chapter 5 presents conclusions and recommendations. An Appendix contains supporting calculations.

2. Background

2.1 Assessment of the Prevalence of Annoyance in Communities

Annoyance is an attitude whose measurement cannot be accomplished without soliciting self-reports from individuals about covert mental states. This does not imply, however, that measurement of annoyance cannot be accomplished in an objective manner. The most widely accepted method for determining the prevalence of annoyance in noise-exposed communities is by attitudinal survey. Surveys generally solicit self-reports of annoyance through one or more questions of the form "How bothered or annoyed have you been by the noise of (noise source) over the last (time period)?" Respondents are typically constrained in structured interviews to select one of a number of response alternatives, often named categories such as "Not At All Annoyed," "Slightly Annoyed," "Moderately Annoyed," "Very Annoyed," or "Extremely Annoyed." Other means are sometimes used to infer the prevalence of annoyance from survey data (for example, by interpretation of responses to activity interference questions or by construction of elaborate composite indices), with varying degrees of face validity and success.

Standardization of social survey techniques employed in noise-related attitudinal studies is poor. Surveys differ from one another in the method of interviewing (face to face, telephone, mail), sampling plans (random, purposive, stratified, panel, independent, etc.), questionnaire length and wording, response scales, adequacy of acoustic measurements, specificity of questioning about the period and noise source(s) of interest, number of interviewing sites and rounds of interviews, and so forth. Most survey designs tacitly assume that community noise exposure is static, and that attitudes toward noise exposure are fully developed and stable at the time of interviewing. Few studies have attempted to assess the rates of increase and decrease of annoyance with changes in noise exposure.

Notwithstanding these procedural and substantive differences in quantification of annoyance, the eventual product of an assessment of the noise-related prevalence of annoyance is generally a set of paired observations of measured (or at least estimated) noise exposure values and percentages of respondents describing themselves as annoyed in varying degrees.

2.2 Nature of Self-Reports of Annoyance

A self-report of annoyance can be viewed as composed of 2 logically independent components: a component directly associated with noise exposure, and a component associated with the willingness of a respondent to describe himself as annoyed in some degree.[1] The latter component is referred to henceforth as "response bias." The 2 components are confounded in a verbal report of the form "I'm very annoyed by aircraft noise in this neighborhood," since there is no way to determine the contributions of the acoustically related and the response bias components to the expressed degree of annoyance on the basis of the self-report alone.

For lack of adequate means of separating the 2 components of self-reported annoyance, interpretations of the prevalence of annoyance in communities are generally based on the assumption that the contributions of response bias to self-reported annoyance are negligible. The experiences of many environmental planners provide ample anecdotal evidence that this is sometimes an unwarranted assumption. It would also be an unnecessary assumption if theory-based tools were available to permit estimation of the relative influences of the 2 components of self-reported annoyance.

2.3 Interpretation of Observed Prevalence of Annoyance in Communities

Given that acoustic and nonacoustic determinants are confounded in self-reports of annoyance, it follows that they are also confounded in the proportion of respondents at an interviewing site who describe themselves as highly annoyed by noise exposure. In other words, it is impossible without theoretically-based methods to distinguish the relative contributions of acoustically related annoyance and response bias in the prevalence of annoyance that can be documented by social survey. In one community in which 20% of the residents describe themselves as highly annoyed, essentially all of the annoyance might be attributable to noise exposure alone. In another community in which 20% of the residents describe themselves as highly annoyed, little if any of the annoyance might be attributable to noise exposure. In yet another community, some of the observed prevalence of annoyance might be due to noise exposure, and some due to nonacoustic factors.

In communities in which the prevalence of annoyance is attributable predominantly to acoustic exposure, reductions in exposure (obtained by means such as reductions in numbers of operations or substitution of quieter aircraft for noisier aircraft) can be expected to lead to reductions in prevalence of annoyance. In communities in which the prevalence of annoyance is controlled by nonacoustic factors,

[1]Similar views are commonly adopted in applications of statistical decision theory such as the psychophysical Theory of Signal Detectability (Green and Swets, 1966).

there may be little or no reduction in annoyance associated with such measures. Environmental planners who must evaluate the efficacy of alternatives to a proposed change in flight operations must therefore have means at their disposal for understanding and predicting the relative contributions of both determinants of the prevalence of annoyance in communities.

2.4 Overview of Probabilistic Model of Annoyance

Fidell, Schultz, and Green (1988) have described a probabilistic model of the relationship between noise exposure and the prevalence of annoyance observed in a community. The only free parameter of the model is the criterion level of noise exposure that individuals adopt to describe themselves as highly annoyed. The model and its assumptions are briefly reviewed below. Readers are referred to Fidell, Schultz and Green (1988) for a detailed explanation of the probabilistic model.

A basic assumption of the model is that Day Night Average Sound Level (DNL) provides an adequate description of the integrated noise exposure produced in a community by environmental noise sources such as aircraft flyovers. This exposure is regarded as a treatment given to a population of individuals. The reactions of individuals in the community to this exposure are summarized by a random variable x, assumed to be exponentially distributed with a mean population value of m. This mean parameter m is assumed to grow as a power-law transformation of the noise exposure DNL, just as effective loudness of sounds grows as sound energy raised to the 0.3 power (Stevens, 1972). Thus, noise exposure establishes a distribution of reactions within a community with a mean value that grows monotonically but nonlinearly with magnitude of noise exposure.

Individuals are assumed to describe themselves as highly annoyed if their reaction x to the noise exposure exceeds some criterion A. In other words, their self-reports of annoyance are viewed as though they were the product of a rational decision-making process. The proportion of the population reporting high annoyance can therefore be predicted from the area of the distribution of x that is greater than the value of the criterion adopted for reporting annoyance A. Because DNL is taken as the appropriate noise metric of community noise exposure, and because m is assumed to be a power-law transformation of that exposure with an exponent of 0.3, the only free parameter of the model is the annoyance-reporting criterion A.

The value of the average criterion adopted for reporting annoyance may vary from interviewing site to interviewing site for any of a number of nonacoustic reasons. The criterion value may differ among interviewing sites because the residents of one neighborhood value commerce generated by airport operations more highly than residents of another, because greater media or political attention has been focused on environmental problems in one neighborhood than in another, because non-environmental problems are more pressing to residents of one neighborhood than of another, and so forth.

It is the prescriptive nature of this model that permits it to be used to make independent estimates of the relative influences of acoustic and nonacoustic factors to the apparent prevalence of noise-induced annoyance. Since the acoustically driven component of reaction to noise exposure is asserted to grow as does loudness, deviations from this predictable growth rate can be attributed to the effects of nonacoustic factors on self-reported annoyance.

The issue of present interest is how to estimate the values of the annoyance-reporting criterion A that are adopted under different circumstances and in different communities. A strategy for doing so is described in the next chapter.

3. Estimating Values of the Criterion for Reporting Annoyance

This chapter describes the application of the probabilistic model of Fidell, Schultz and Green (1988) that was summarized in the previous chapter to the data set of social survey findings produced by Fidell, Barber, and Schultz (1989). The goals of this application are (1) to develop quantitative estimates of variability in the response bias criterion adopted by social survey respondents in different communities; and (2) to investigate whether these values differ for different noise sources. Additionally, since data were collected in some social surveys at multiple interviewing sites located near the same community noise source(s), comparisons of the values of the annoyance criterion A among interviewing sites permit inferences about the variability of this parameter within surveys. The central idea of this analysis is to treat the value of annoyance measured at each survey interviewing site as an independent estimate of the annoyance criterion A.

3.1 Transformations of Basic Equations of Model

Noise exposure measured at each interviewing site L_{dn_i} and the proportion of highly annoyed individuals $P_i(HA)$ may be assumed to be independent measurements from which an estimate of the annoyance criterion A_i at each site may be inferred. (Estimates of noise exposure at each site may also differ because of error in acoustic measurement and for other reasons which are addressed in Section 3.7.) Treating site-specific information in this way, it is reasonable to average the individual estimates A_i to form a mean estimate of annoyance A_m for a particular survey.

The process of estimating values of the annoyance criterion is facilitated by a few transformations of the model's basic equations. Equation 2 of Fidell, Schultz and Green (1988) may be used to estimate A_i as:

$$P(HA)=e^{-(A/m)} \qquad (3\text{-}1)$$

where P(HA) is the proportion of highly annoyed; A is the annoyance criterion; and m is the mean of the exponential density of annoyance reactions, $1/m\ e^{-x/m}$. (The equation expresses the area of the exponential density function above the value A.)

Writing out the value of m explicitly (as in Equation 3 of Fidell, Schultz, and Green, 1988) yields:

$$m = [10^{L_{dn}/10}]^{0.3} \qquad (3\text{-}2)$$

Treating exposure levels at separate interviewing sites within surveys and estimates of annoyance at each interviewing site individually produces:

$$-\ln [P_i(HA)] = A_i / [10^{L_{dn_i}/10}]^{0.3} \tag{3-3a}$$

$$10 \log\{-\ln[P_i(HA)]\} = 10 \log A_i - 0.3\, L_{dn_i} \tag{3-3b}$$

$$10 \log A_i = 0.3\, L_{dn_i} + 10 \log\{-\ln[P_i(HA)]\} \tag{3-3c}$$

The annoyance criterion for an entire survey may now be expressed as the mean of annoyance criteria measured at subsites within a survey as:

$$10 \log A_m = 10 \log \Sigma(A_i/n) \tag{3-4}$$

In keeping with the notation of Fidell, Schultz and Green (1988) defining the quantity A^* as 10 log A, A^*_m and A^*_i may be defined as:

$$A^*_m = 10 \log A_m \tag{3-5a}$$

and

$$A^*_i = 10 \log A_i \tag{3-5b}$$

All of the relationships needed to make independent estimates of the acoustic and nonacoustic contributions to the observed prevalence of annoyance in communities have now been defined.

3.2 Accuracy of Estimation of A^*_m from A^*_i

Although the estimate of the mean value of the criteria for reporting annoyance for an entire survey using Eqs. 3-3c and 3-4 is intuitively plausible, there is more than one way that such a quantity could be estimated. This section demonstrates that this estimation scheme is a sensible and reasonably accurate one. The most straightforward estimate of the annoyance criterion for an entire survey would be the criterion value that minimizes the sum of squared deviations between the predicted and obtained value of P_i(HA) for each site in the survey (a "least-squares" estimate). Such an estimate is calculated for one survey and compared with the average of the A^*_i values to demonstrate that the average value is a good estimate of the average annoyance criterion for the entire survey.

The data reported by Alexandre (1970), the "French Aircraft Survey," suffice for this purpose. The original data, plotted as Fig. 26 of Schultz (1978), are reproduced here in Figure 3-1 and Table 3-1.

Solving for A_i at each site and averaging yields the mean value A_m=22.2. This value and Eq. 3-3c yield a predicted proportion of highly annoyed individuals expected according to the model. The resulting root-mean-square (rms) error is 0.019. This rms error for a number of values of A^* is displayed in Table 3-2. The value of A^* producing the smallest rms error is 22.3. Deviations from this value increase the rms error. This minimum value for A^*, 22.3, is close but not equal to the value of A^*_m = 22.2 calculated by averaging the values of A^*_i obtained at the 6 interviewing sites of the survey. Thus, while the estimate of A^*_m is not a least-squares estimate, it is reasonably close to one. Both the difference in the A^* values of 0.1 (22.2 - 22.3) and the difference of 0.002 (between an rms error of 0.017 and 0.019) are small enough to be negligible.

Thus, averaging the value of A^*_i provides a convenient and simple method of estimating the annoyance criterion of an entire survey. It not only represents the mean annoyance criterion as estimated from all interviewing sites within a survey, but also provides a reasonable way to minimize the overall deviation between the predicted prevalence of annoyance and that measured in the survey.

3.3 Expressing the Annoyance Criterion A^* in terms of DNL

The criterion for reporting high annoyance has been expressed so far with respect to a compressive scale of acoustic energy. The criterion value A is a point on a scale of subjective magnitude, or loudness, of the noise exposure. As Eq. 3-3b indicates, a change of one unit in 10 log A requires a change of (1 / 0.3) units of DNL to hold the proportion of reports of high annoyance constant. The criterion for reporting annoyance may also be expressed in terms of a more familiar scale, such as noise exposure in DNL. Another means of expressing the noise criterion A^* (as a point along a noise exposure scale) is therefore introduced:

$$D^* = (1/0.3)\,A^* = 3.333(A^*) \qquad (3\text{-}6)$$

The annoyance-reporting criterion can be expressed on this alternate scale in decibel-like units equivalent to exposure in DNL units. For example, the A^* value of 22.2 for the Alexandre survey is equivalent to a D^* value of 74 dB. D^* represents the minimum noise level (expressed in units of L_{dn}) required to report high annoyance. D^* can also be used to compare the variability of annoyance criteria among surveys in decibel-like units.

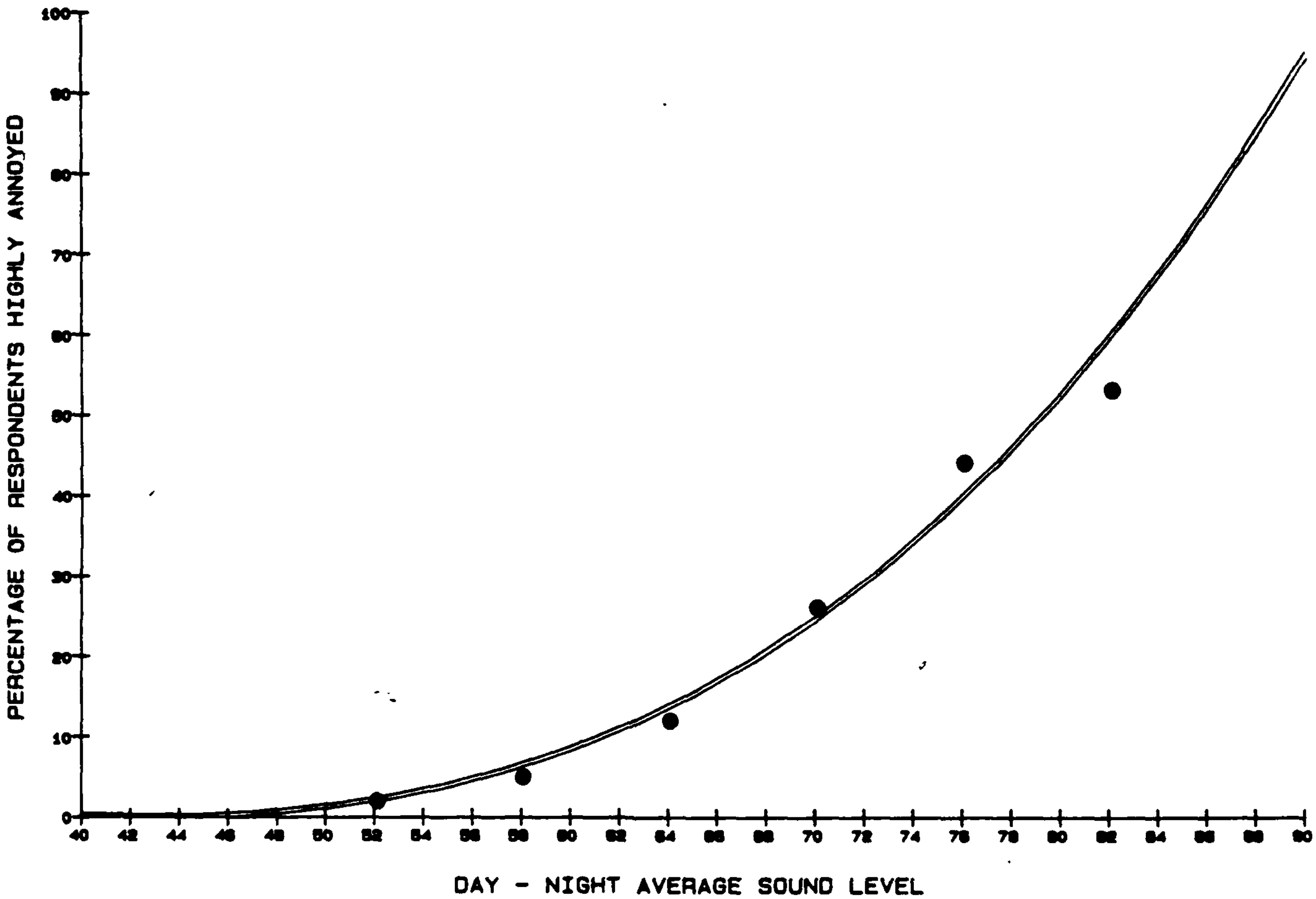

Figure 3-1: Data Reported by Alexandre (1970), adapted from Figure 26 of Schultz (1978).

Table 3-1: Data From "French Aircraft Survey" (Alexandre, 1970).

$A^*_m = 22.2$, equivalent to $L_{dn} = 74.0$.

Measured L_{dn}	Observed HA	Predicted[1] HA	Error
52.1	0.020	0.011	0.009
58.1	0.050	0.050	0.000
64.1	0.120	0.138	-0.018
70.0	0.260	0.270	-0.010
76.1	0.440	0.421	0.019
82.1	0.530	0.565	-0.035

Square root of mean of error = 0.019

[1]Using A^* of 22.2 for $10\log A_i$ in Eq. 3-3c and solving for P(HA).

Table 3-2: Comparison of Least Squares Estimates Produced by Several Values of Annoyance Criterion.

Value of A^*	RMS error
21.9	0.032
22.0	0.026
22.1	0.022
22.2	0.019
22.3	0.017
22.4	0.018
22.5	0.021
22.6	0.025
22.7	0.029
22.8	0.035

3.4 Estimating D^*_m from Survey Data

The estimation procedure is used next to calculate values of D^*_m for a data set derived from 32 surveys. It is convenient to divide the data from the 32 surveys into 3 sets. One set consists of the 12 surveys considered by Schultz (1978) to be "clustering" surveys. The second set consists of 5 other surveys considered by Schultz to be "nonclustering" surveys. The third set consists of 15 surveys published after the 1978 Schultz curve was derived. Four of these studies (mentioned in addenda by Schultz (1978)) were not included in the 1978 equation. Eleven were published later (2 of these "new" surveys consist of data from a single survey about reactions to 2 types of noise sources). Each of these subsets is addressed in turn.

3.4.1 Estimates of D^*_m from Clustering Surveys of Schultz

Schultz (1978) synthesized the dosage-effect relationship from the data of 12 clustering surveys which yielded 161 data points in good agreement with one another. Figure 3-2 shows the data from these surveys. The solid curve of the figure shows the predictions of the probabilistic model for a criterion value of annoyance A^* of 21.9 ($D^* = 73$ dB). This is the average value of A^* for the 12 clustering surveys. The rms deviation of the predicted from the obtained value for the proportion of highly annoyed judgments is .092. The predicted line accounts for 83% of the variance. This value provides a fit to the data that is essentially indistinguishable from that of the cubic equation suggested by Schultz in terms of its proximity to the data points, especially in the range of exposure levels of greatest practical concern. Unlike the relationship suggested by Schultz, however, the prevalence of annoyance predicted by the probabilistic model asymptotically approaches a proportion of unity at high exposure levels.

The same data are shown in Fig. 3-3 where the individual values of DNL have been subtracted from a criterion value estimated from each individual survey. This procedure adjusts the survey data for a criterion for reporting annoyance peculiar to each survey. First, a value of A^*_i was estimated for each of the subsites within the 12 surveys by means of Eq. 3-3c. Next, a value of A^*_m was found for each survey from Eq. 3-4. That value, divided by the compressive nonlinear exponent, provided a value of D^*_m which was then subtracted from the DNL value determined in that survey. This scaling of the abscissa normalizes the data of each survey by setting the proportion of highly annoyed to 1/e (0.37) at a value of 0 dB. The transformed scale provides a prediction of the proportion of respondents describing themselves as highly annoyed that is independent of the criterion value associated with any individual survey.

Figure 3-3 shows the results of these transformations. As can be seen, there is only a slight improvement in the fit to the data. The reason that the change is so small is that the data of the 12 surveys that Schultz considered "clustering" were highly similar. The rms deviation of the predicted from the obtained value for the proportion of highly annoyed judgments is slightly lower (.089). The predicted line accounts for 84% of the variance.

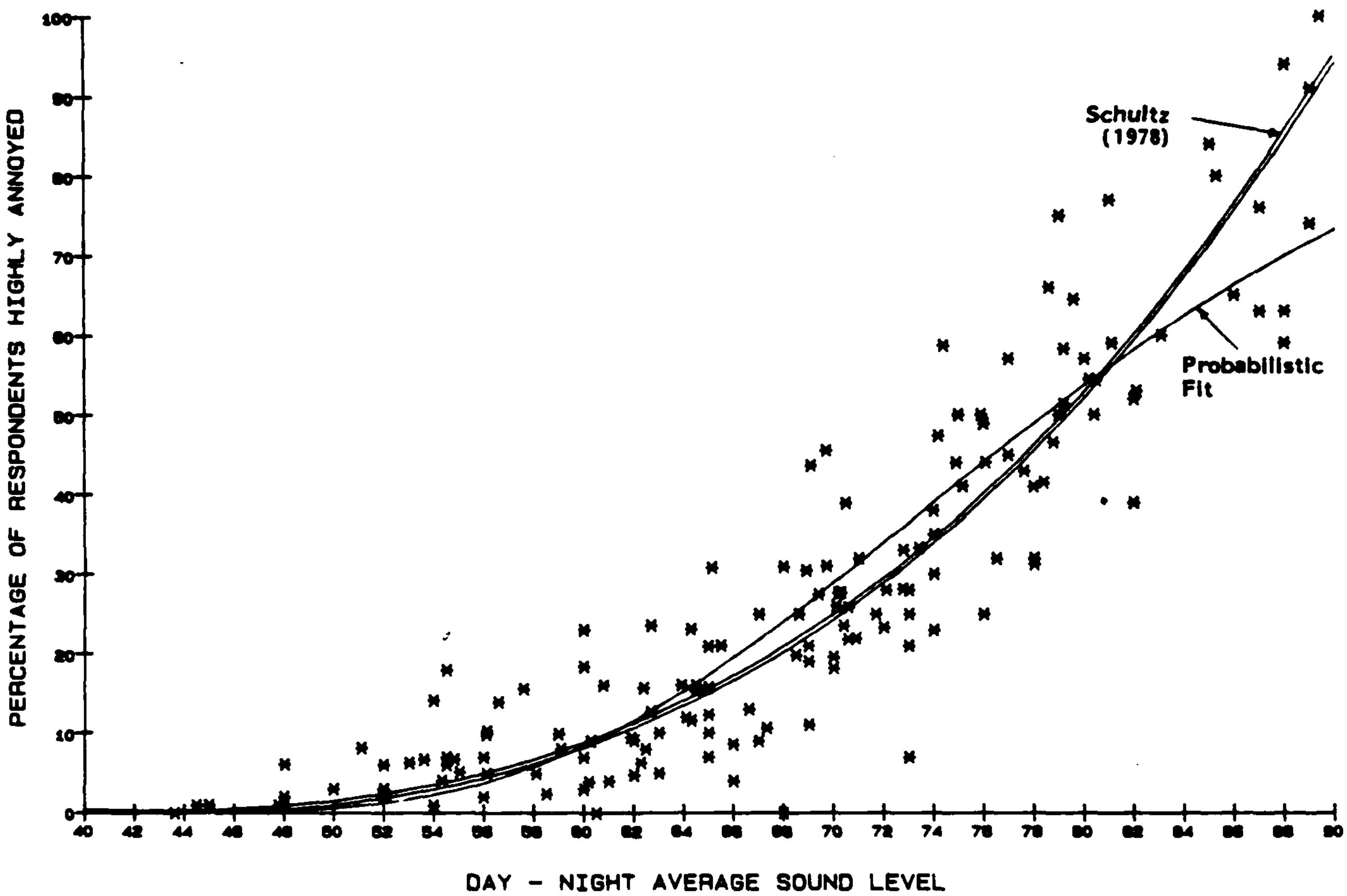

Figure 3-2: Data from 12 Clustering Surveys of Schultz (1978) Fitted by Third-Order Polynomial Approximation and by Probabilistic Model.

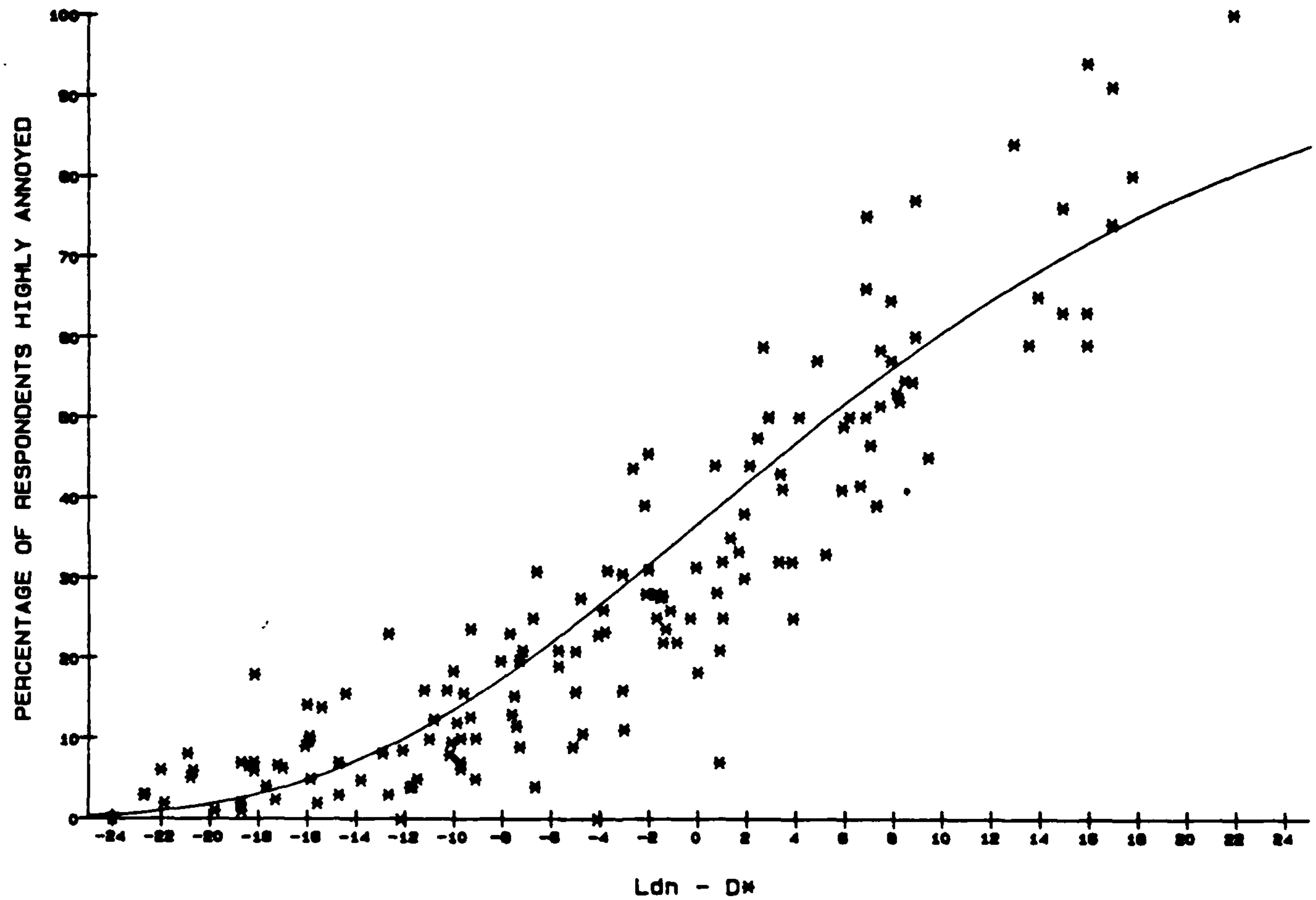

Figure 3-3: Rescaled Data from 12 Clustering Surveys.

3.4.2 Estimates of D^*_m from Nonclustering Surveys of Schultz

The same transformations may be applied to the data of 5 nonclustering surveys.[2] Figure 3-4 shows the raw data. The solid line is the predicted value based on a single value of $A^* = 21.7$ ($D^* = 72.5$ dB), the average value obtained for the 5 surveys. The rms deviation of the predicted from the obtained value for the proportion of highly annoyed judgments is nearly twice the value obtained for the clustering surveys (0.20). The predicted line accounts for only 39% of the variance.

Values of D^*_m estimated from each of the separate surveys were used to rescale the data of Fig. 3-4. The rescaled data are plotted in Fig. 3-5. The value of D^*_m for each survey is listed in Table 3-2. The result of the transformation is a considerable reduction in the scatter of the data (see Fig. 3-5). Further, the data points now cluster about the solid line representing the prediction of the probabilistic model. The rms deviation of the predicted from the obtained value for the proportion of highly annoyed judgments is cut in half (from 0.20 to .098). The predicted line accounts for 86% of the variance.

3.4.3 Estimates of D^*_m from the "New" Surveys

Figure 3-6 shows the data of 15 surveys published since the 1978 synthesis of Schultz. Figure 3-7 replots the same data on the rescaled abscissa DNL - D^*_m. A reduction in the scatter of the data is evident. The rms deviation of the predicted from the obtained value when $D^* = 73$ dB (the average value for these surveys) is .188, accounting for only about 4% of the variance. However, using a different value of D^* for each survey, the rms deviation of the predicted and obtained values for the proportion of highly annoyed respondents becomes .127, and the predicted line accounts for 57% of the variance. Assuming that respondents in the different surveys adopted different criteria for reporting annoyance, it is possible to predict the proportion of highly annoyed individuals with fair accuracy (sufficient to account for 57% of the variance). If respondents in each survey had adopted the same annoyance reporting criterion, it would be necessary to conclude that DNL is independent of the expression of annoyance judgments. Accounting for 4% of the variance means the correlation between annoyance judgments and DNL is only 0.20. Such a low correlation would imply a need for a different noise metric to summarize the effects of noise exposure on communities. The assumption that annoyance-reporting criteria differ in different communities increases the correlation between exposure and annoyance to 0.75, and justifies reliance on DNL as a summary measure of community noise exposure.

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[2]Table II of Schultz lists 7 nonclustering studies, one of which (First Heathrow) is also included among the clustering surveys with a different interpretation of its response scale. Data from the 1968 Swedish Traffic survey were omitted from the current analysis due to the uninterpretability of its response scale.

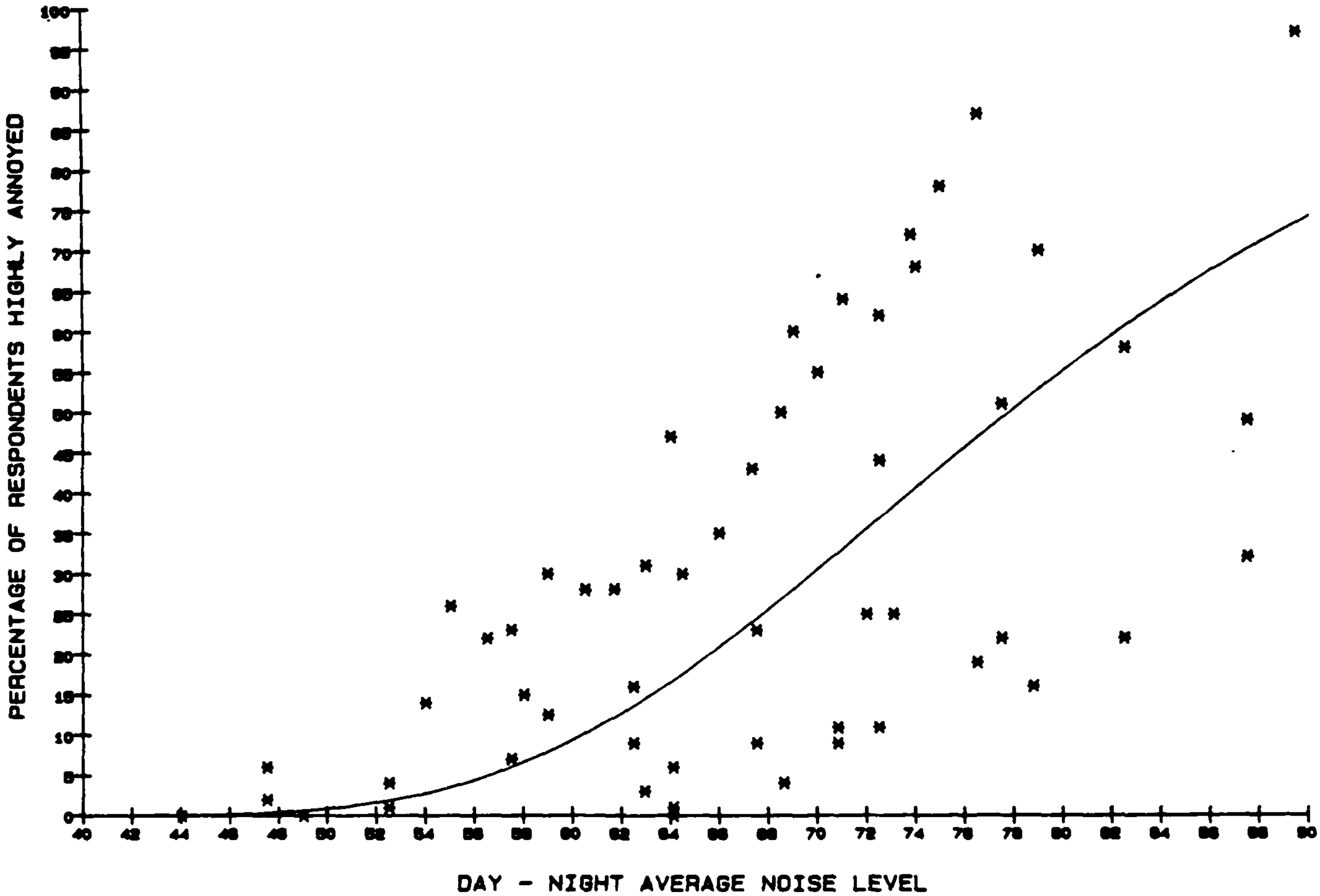

Figure 3-4: Data from 5 Nonclustering Surveys.

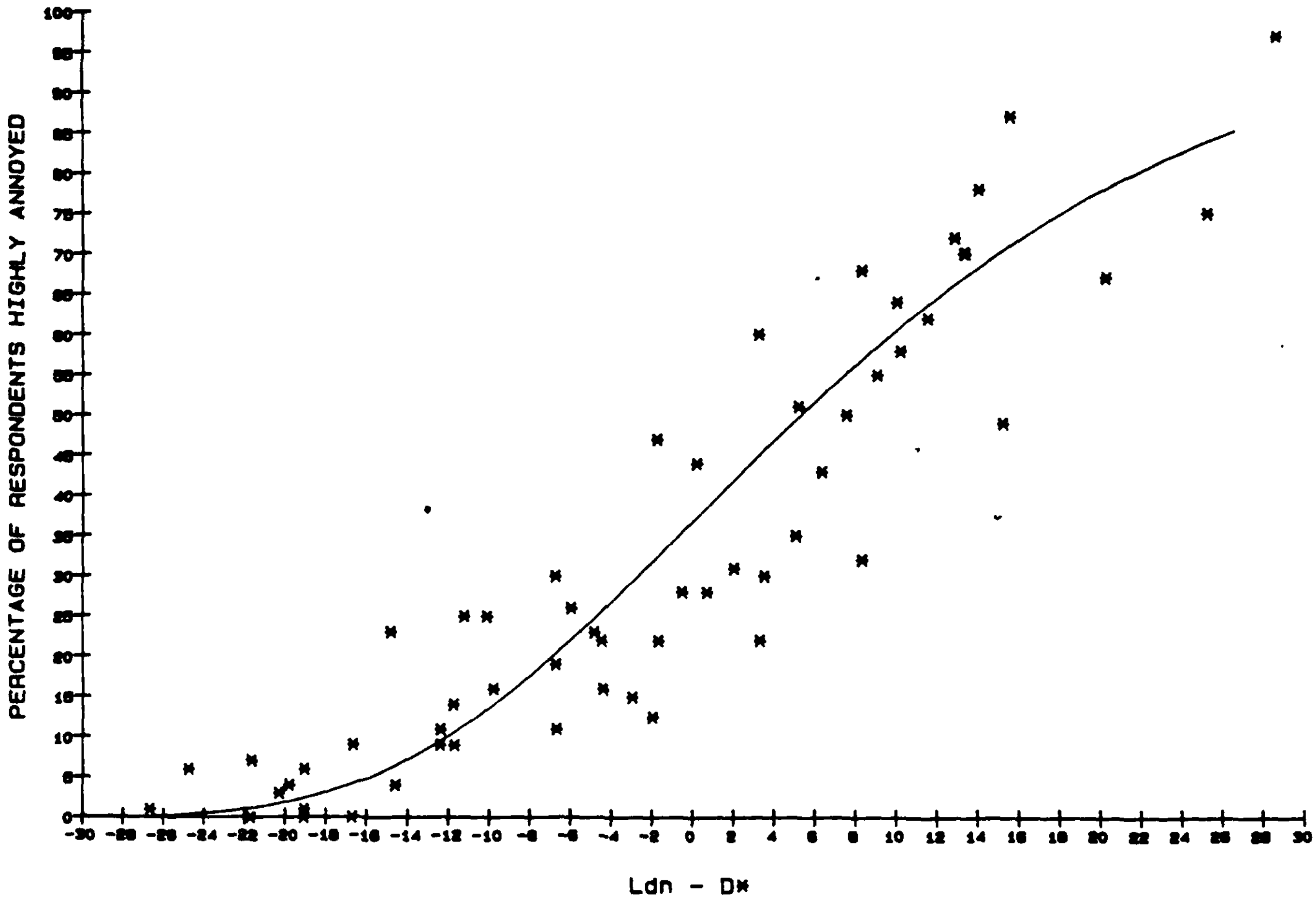

Figure 3-5: Rescaled Data from 5 Nonclustering Surveys.

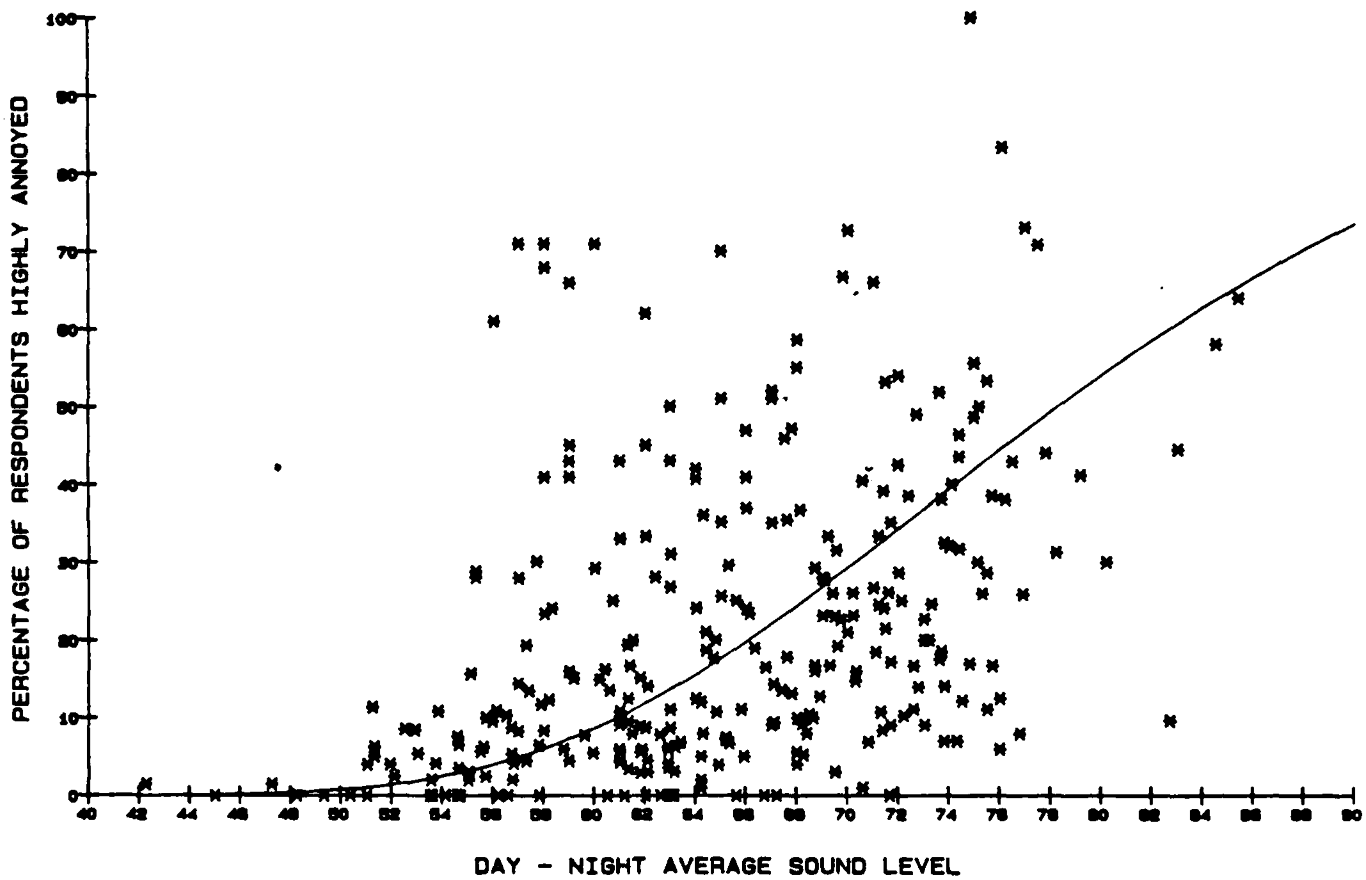

Figure 3-6: Data from 15 Surveys Published Since 1978.

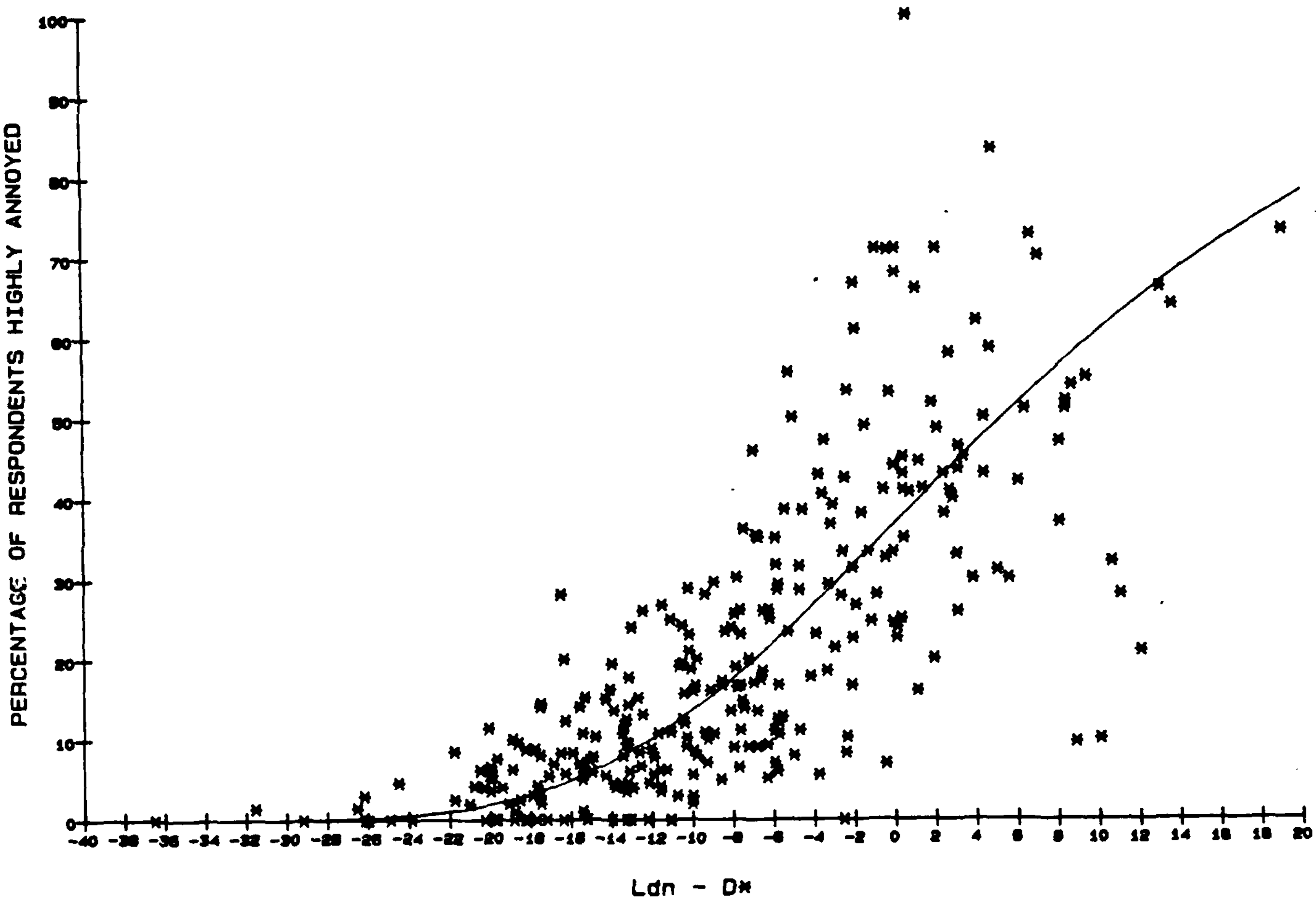

Figure 3-7: Rescaled Data from 15 Surveys Published Since 1978.

3.5 Observed Differences in Annoyance Criteria Among Surveys

Table 3-2 lists values of the criteria for reporting annoyance D^*_m and the variance of D^*_m estimated from the 3 data sets. The standard deviation of the D^*_i values represents the variability of the annoyance criteria measured at the various sites within a given survey. This provides an index of the consistency of the measuring sites within the noise survey and is useful in estimating measurement error within the surveys. Computing the mean and standard deviation of D^*_m values measured in different surveys facilitates analyis of the consistency of the annoyance-reporting criterion among surveys. These quantities are listed at the bottom of each section of the table. The data in Table 3-2 are examined in 3 groups.

The first group of surveys consists of the 12 data sets of the 11 clustering surveys of Schultz (1978). The mean estimate of D^*_m in this group of surveys is 73.1 dB, with a standard deviation over the different surveys of only 2.7 dB. The total range of D^*_m for the 12 data sets is small (only 10.5 dB).

The second group of surveys appearing in Table 3-2 summarizes estimates from 5 surveys termed "nonclustering" by Schultz (1978). The mean value for D^*_m in this group of surveys is 72.5 dB, a value within 1 dB of the mean for the clustering surveys. The value of the standard deviation (9.2 dB), however, is more than 3 times greater than the standard deviation computed over the clustering surveys. In this group of surveys, the range of D^*_m for the 5 surveys is 22.3 dB. One can appreciate one of the reasons that Schultz considered these surveys nonclustering.[3]

The third group of surveys contains data from 15 studies published since the derivation of the 1978 dosage-effect relationship (4 in addenda of Schultz (1978) and 11 others). The mean value of D^*_m for this group is 73 dB, with a standard deviation of 8.25 dB. The range of values is 31.4 dB. The range of these values is affected greatly by 4 aircraft noise surveys in which respondents adopted rather low criteria for describing themselves as highly annoyed. Of the 4 surveys with the greatest intolerance of noise exposure ($D^*_m < 66$ dB), 3 were conducted at relatively small airports: Burbank, Orange County, and Westchester. The 4th survey was conducted at Toronto International Airport. If these 4 studies are excluded, the range of D^*_m drops to only 18.1 dB, a range somewhat smaller than that of the nonclustering surveys.

In summary, a considerable range of values is apparent in the criterion value D^*_m over the 34 data sets from 32 surveys. The communities' criteria for reporting annoyance are equivalent to changes in DNL of 20 to 30 dB. One potential explanation for these large changes might be differences in the primary neighborhood noise source. This possibility is examined in the next section.

[3]The present model provides a means for understanding how identical percentages of residents (say 20%) exposed to noise levels differing by 22 dB, say DNL = 53 dB and DNL = 75 dB, could describe themselves as highly annoyed. The model attributes such differences in the observed prevalence of annoyance to the same exposure to factors having nothing to do with the noise exposure, such as local publicity or economic interests.

Table 3-3: Values of D^*_m for All Surveys.

Summary of Analysis of Schultz's (1978) Clustering Surveys		
Survey	D^*_m	*Sigma of* D^*_i
French Aircraft (Alexandre, 1970)	74.0	1.20
Second Heathrow Airport (MIL Research, 1971)	74.8	4.68
First Heathrow Airport (McKennell, 1963)	70.0	4.35
London Traffic (Langdon, 1976)	71.8	3.57
Munich Aircraft (Rohrman et al., 1974)	72.1	9.83
Paris Street (Aubree et al., 1971)	74.2	1.58
French Rail (Aubree, 1975)	78.1	2.02
Swedish Aircraft (Rylander et al., 1972)	72.7	5.96
Swiss Road (Grandjean et al., 1973)	75.8	2.46
Swiss Aircraft (Grandjean et al., 1973)	67.6	13.80
USA 24 Site (Fidell, 1978)	72.0	4.28
Los Angeles Airport (Fidell and Jones, 1975)	73.8	2.06
Average	73.1	4.65
Standard Deviation	2.7	3.73
Maximum	78.1	13.80
Minimum	67.6	1.20

Table 3-3: continued.

Summary of Analysis of Non-Clustering Surveys		
Survey	D^*_m	*Sigma of* D^*_i
French Expressway (Lamure, 1976)	61.0	7.32
Swedish Road (Rylander et al., 1976)	83.2	4.33
Tracor Large City Aircraft (Patterson and Conner, 1973)	73.4	6.08
Tracor Small City Aircraft (Conner and Patterson, 1972)	79.2	6.87
Vienna Street Traffic (Bruckmayer and Lang, 1967)	65.8	7.70
Average	72.5	6.46
Standard Deviation	9.2	1.33
Maximum	83.2	7.70
Minimum	61.0	4.33

Table 3-3: concluded.

Summary of Analysis of Surveys not Treated by Schultz		
Survey	D^*_m	*Sigma of* D^*_i
U.S. Airbase (Borsky, 1985)	71.8	7.34
Antwerp Street (Myncke et al., 1977)	80.3	5.68
Brussels Street (Myncke et al., 1977)	77.9	7.48
Burbank Airport (Fidell et al., 1985)	58.0	11.38
Canadian Road (Hall and Taylor, 1977)	81.8	5.92
Danish Street (Relster, 1975)	71.3	6.72
British Rail (Fields and Walker, 1982)	73.8	10.28
Aircraft/Traffic Comparison (A/C only) (Hall et al., 1977)	63.3	5.57
Aircraft/Traffic Comparison (Traffic only) (Hall et al., 1977)	72.9	3.42
Orange County Airport (Fidell et al., 1985)	58.6	1.83
Australian Aircraft (Hede and Bullen, 1982)	74.5	5.86
Tramway/Traffic Comparison (Tramway only) (Rylander, 1977)	79.7	4.98
Tramway/Traffic Comparison (Traffic only) (Rylander, 1977)	89.4	6.06
Decatur Airport (Schomer, 1983)	74.0	1.79
Swedish Railroad (Sorensen and Hammar, 1983)	74.6	5.28
Westchester Airport (Fidell et al., 1985)	65.5	3.62
Danish Railroad (Anderson et al., 1983)	74.3	15.08
Average	73.0	6.37
Standard Deviation	8.25	3.37
Maximum	89.4	15.08
Minimum	58.0	1.79

3.6 Is the Annoyance-Reporting Criterion Specific to Noise Sources?

It has been claimed by some (e.g., Kryter, 1982) that prediction of the prevalence of noise-related annoyance in communities should be source specific: that is, different dosage-effect relationships should be used for predicting the annoyance of different noise sources. For example, it is sometimes claimed that aircraft noise exposure is for one reason or another considerably more annoying than noise exposure produced by other sources.

The claim is based for the most part on the observation that the findings of social surveys of the annoyance of aircraft noise tend to cluster at greater levels of annoyance than other transportation noise sources for similar levels of noise exposure. In the present context, this observation suggests that communities adopt a more sensitive criterion (i.e., numerically smaller values of A^* and D^*) for reporting annoyance due to exposure to aircraft noise than to surface transportation noise.

Table 3-4: Comparison of Values of D^*_m for 3 Noise Sources.

Comparison of Values		
Noise Source	D^*_m	*Standard Deviation*
Aircraft	70.15	5.99
Street Traffic	75.51	7.31
Railroad	75.19	1.98

Table 3-3 compares values of D^*_m derived from social surveys of annoyance associated with aircraft, street traffic, and railroad noise. The mean values of D^*_m for these 3 noise sources are 70.2, 75.5, and 75.2, respectively. The small number of railroad surveys may be combined with street traffic surveys without affecting any conclusions. As may be seen in Fig. 3-8, the distributions of D^* in air and surface traffic surveys overlap to a considerable degree. Nonetheless, the mean value for D^*_m in surface transportation studies is about 75.4 dB, whereas the mean value for aircraft sources is 70.2 dB, a difference of 5.2 dB. Thus, people are on average more willing to report annoyance due to aircraft noise exposure than to report annoyance due to street and rail traffic. A t-test ($t_{(15)} = -2.47$, $p < .05$) indicates that a difference of this size is unlikely to arise by chance alone.

This analysis suggests a different interpretation of the observation that aircraft noise exposure is likely to produce a greater proportion of self-reported annoyance than the same level of street traffic or railroad noise exposure. It is not necessary to conclude that such differences are produced by intrinsic differences in the annoyance of the noise sources themselves, nor (as Kryter argues) by differences in the pervasiveness of noise exposure produced by different sources. The present model suggests that people

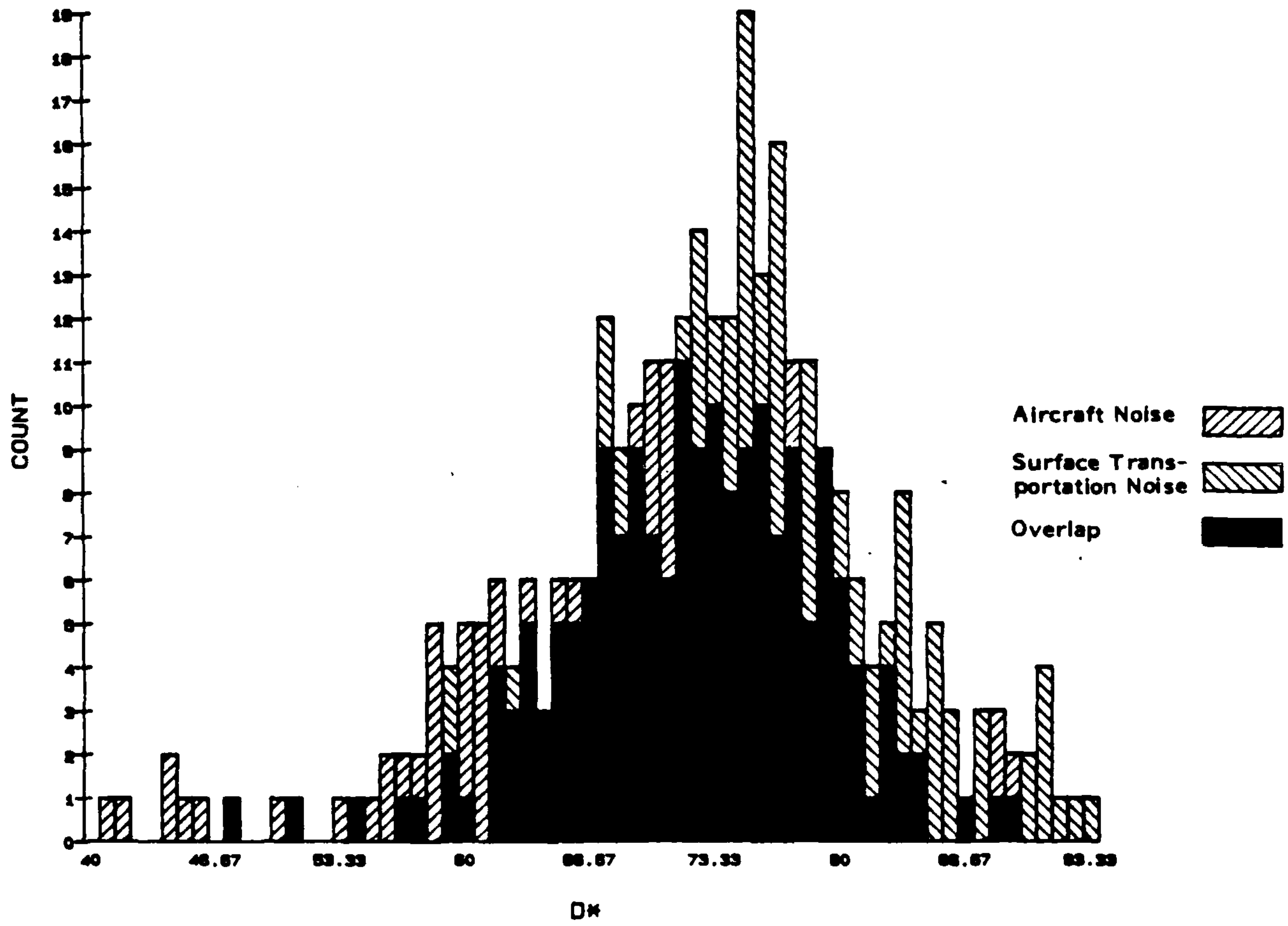

Figure 3-8: Distributions of Surface Traffic vs. Aircraft Noise Response Bias.

adopt different criteria for reporting annoyance from different noise sources. Different noise metrics for aircraft noise and traffic noise are not needed.

This assertion is supported by the fact that the amount of variance accounted for by the predicted line for aircraft noise sources (based on a single $D^* = 70.15$, the average of the aircraft surveys) is 42% (rms deviation = .178) while the variance accounted for using non-aircraft noise sources (based on a single $D^* = 75.43$) is 44% (rms deviation = .146). There is considerable improvement in the fit of the predicted line when the amount of variance accounted for is based on the D^* value from each survey (rather than the mean of the noise source); r^2 for both aircraft and non-aircraft noise sources is 72% (rms variation for aircraft = .125, non-aircraft = .104). Clearly, the DNL scale is as useful for predicting annoyance caused by one noise source as by another.

3.7 Estimates of Variability

The proportion of highly annoyed respondents P_i(HA) and the measured noise exposure for each site within a survey DNL_i have been treated in the preceding analyses as errorless estimates from which the annoyance-reporting criterion A_i may be estimated via Eq. 3-3c. This procedure leads to an *overestimate of the variability* associated with the annoyance criteria, since errors in either of the other quantities are reflected in the resulting estimate of A_i. The magnitude of errors of measurement in noise exposure and in the proportion of highly annoyed respondents must be estimated to establish more realistic bounds on the variability of A_i. Errors in measurement of DNL are addressed first.

3.7.1 Error of Measurement of Exposure

Errors in estimating the noise exposure of survey respondents may arise for several reasons. Perhaps most fundamentally, noise exposure has not been empirically measured in some studies. Studies in which large errors of estimate are likely to have resulted from inference rather than measurement of exposure (e.g., from typical aircraft noise footprints or from assumed average daily traffic figures) have been excluded from the data sets analyzed in this paper.

Empirical measurements are not necessarily representative, however, of the residential noise exposure of all respondents within an interviewing site. The issue is not that outdoor, place-oriented exposure measurements are poorly correlated with personal noise doses, but rather that residential noise exposure is not homogeneous within interviewing sites. Aircraft noise exposure can in some cases (e.g., on bearings orthogonal to flight paths) vary over a range of 5 dB or more within a few blocks. The extensive precautions necessary to maximize the representativeness of noise exposure estimates (e.g., definition of sites with respect to known exposure gradients, multiple measurement positions within sites,

and spatial and population weighting of estimates) are not commonly reported in the literature. Failures to account for nonhomogeneous noise exposure within interviewing sites lead inevitably to uncertainty in estimates of DNL values in survey data.

Yet another source of error in commonly reported community noise measurements is the inability to distinguish between aircraft and nonaircraft sources. This problem is especially acute over a range of exposure levels common to both aircraft and surface transportation sources. DNL values on the order of 60- 65 dB in some neighborhoods in airport environs, for example, may not be attributable primarily to aircraft noise exposure. The problem is less acute at higher exposure levels.

Since there are no practical, quantitative means for determining how representative and source-specific noise exposure estimates in published reports of social survey findings actually are, it is difficult to quantify the error of estimate of DNL in analyses such as those reported in this paper. Lacking such means, the most prudent course may simply be to acknowledge that errors in estimation of DNL almost certainly exist, and that in the current data set they could well range up to about 3 dB.

3.7.2 Error of Measurement of Annoyance

Estimating the variability in measurements of the proportion of highly annoyed respondents in a survey sample is much more straightforward. The assumption that the variance of the proportion is binomially distributed permits its estimation as pq/N, where p is the proportion highly annoyed q = 1-p and N is the number of respondents. Standard deviations of the proportion highly annoyed on the order of .05 to .10 are typical of much of the survey data. Changes as great as 0.1 in the proportion of highly annoyed individuals are associated with changes of about 4 dB in DNL even in the steepest part of the dosage-effect relationship (see Eq. 3-1). Thus, the error in estimating the percentage of highly annoyed individuals can be represented as a random variable with a standard deviation no greater than about 4 dB.

Assuming that the errors of measurement of exposure and of annoyance are independent, the combination of errors as great as 3 dB in estimating exposure and 4 dB in DNL associated with estimates of the proportion highly annoyed is unlikely to cause a total error of more than about 5 dB ($(3^2 + 4^2)^{1/2}$). Such an upper bound appears to be a reasonable value for the current data set. Table 3.3 displays the standard deviations computed from the values of D^*_i estimated at the different sites within each of the surveys. The average standard deviations of D^*_i range from 4.7 dB to 6.5 dB in the 3 subsets of surveys. Since there are undoubtedly some real changes in the value of D^*_i for different sites within surveys, an estimated upper bound of 5 dB appears reasonable. The variability observed in the non-clustering and new surveys exceed this upper bound by an even greater margin.

If this variance is simply the sum of the variances due to changes in D^*_m among the surveys and an error of measurement having a standard deviation of 5 dB, then the standard deviation associated with changes in criterion values is 8.2 dB = $(6.5^2 + 5^2)^{1/2}$. Thus, even excluding error of measurement,

considerable variability remains in the criterion for reporting high annoyance if the current collection of surveys is representative.

4. Discussion

4.1 Comparison of Theoretically- and Empirically-Derived Dosage-Effect Relationships

Figure 4-1 shows the relationships among the dosage-effect relationship derived by Schultz (1978), the least squares quadratic fit to the empirical data (511 points)[4], and the theoretically-based function. The value of the annoyance-reporting criterion (expressed in L_{dn}-equivalent units) is $D^* = 72.95$ dB, the average value for all 34 data sets.

All of the relationships are reasonably close to one another: well within ± 5% over the parts of their ranges of primary interest for environmental planning purposes. Over most of their ranges, all of the functions also lie within the bounds of quadratic least squares functions fitted to the upper and lower 95% confidence intervals of the data points from which the relationships were derived.

The 1978 Schultz curve and the theoretically-derived functions predict a slightly lower prevalence of annoyance in communities at exposure levels less than about $L_{dn} = 65$ dB than the best fit to the empirical data. The 1978 Schultz curve predicts a lower prevalence of annoyance because it was forced to zero at $L_{dn} = 45$ dB. The theoretically-derived function also approximates zero at about the same exposure level, but not for any theoretically important reason; it could equally well asymptote at a non-zero prevalence of annoyance in the same region.

Perhaps the most notable differences among the dosage-effect relationships are their errors in associating L_{dn} values with given percentages of the community highly annoyed. The range of noise exposure values of primary interest to environmental planners is 45 dB $< L_{dn} <$ 75 dB. The rms error in the prediction of the proportion of highly annoyed judgments for the probabilistic model in this range (based on a prediction derived from using each individual survey's annoyance criterion) is only .108, while the corresponding figure for the 1978 Schultz Curve is .162. In other words, environmental planners who base their predictions of the prevalence of annoyance on the dosage-effect relationship derived from the probabilistic model can reduce their errors of prediction by one third with respect to predictions based on the Schultz curve.

[4]The 511 data points include: (1) 161 "original" data points used by Schultz (1978) to derive a dosage-effect relationship: (2) 292 data points published since the derivation of the 1978 curve: and (3) 58 data points from the group Schultz (1978) considered "nonclustering." The "nonclustering" data points were included in the present analysis to illustrate the compressive transformation performed by the theoretically-based function. The quadratic fit shown in Figure 4-1 was applied to all 511 data points to be consistent with the present analysis. The difference between the quadratic fit to 453 data points derived by Fidell et al. (1989) and the fit to the 511 data points is negligible.

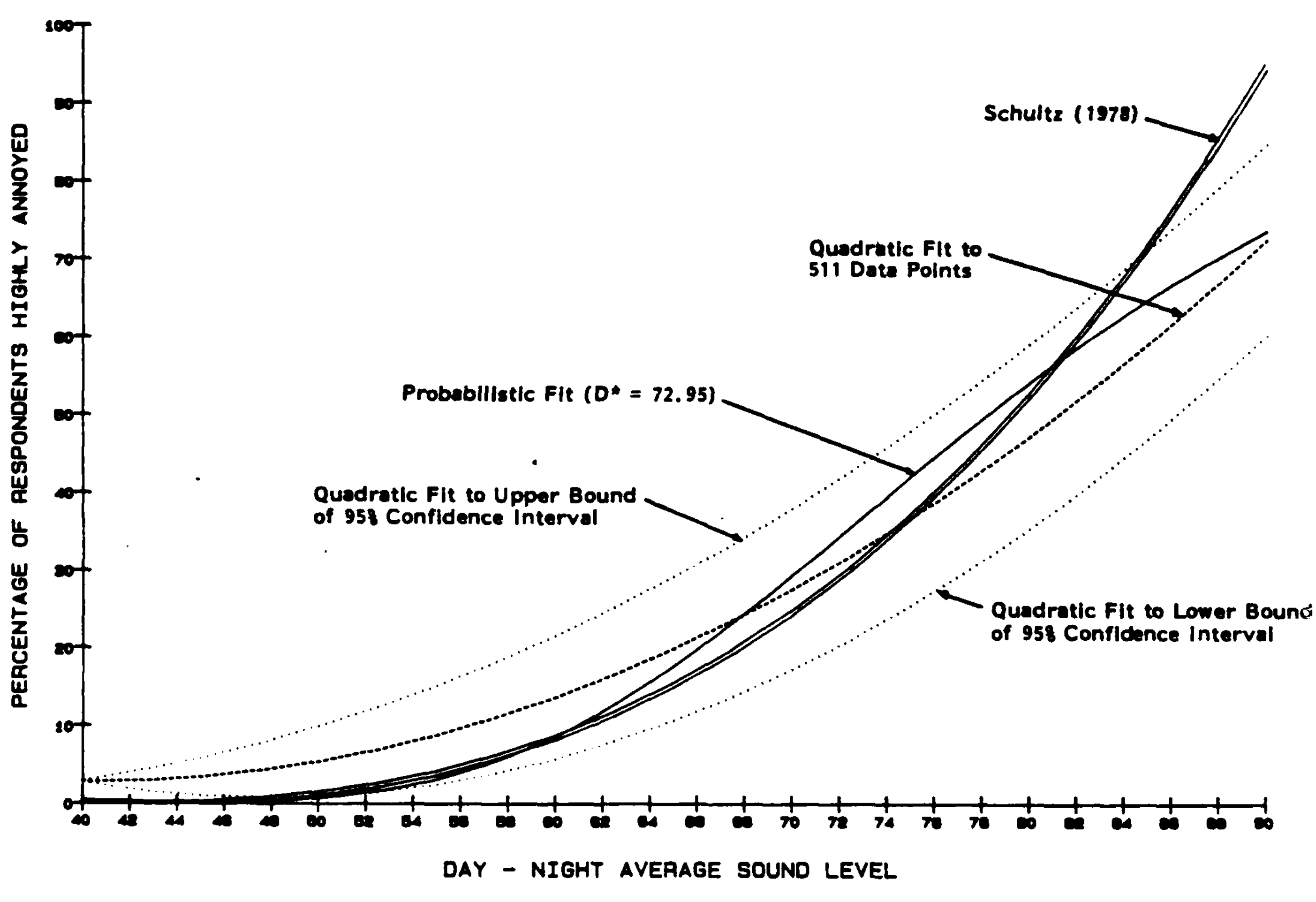

Figure 4-1: Comparison of Empirical and Theoretical Dosage-Effect Relationships.

4.2 Implications of Findings

The findings of the analyses developed in the previous chapters show that it is possible to make independent estimates of the relative contributions of acoustic and nonacoustic factors to the observed prevalence of annoyance in communities. The quantitative findings of the analyses also confirm the usefulness of a systematic, theoretically-based interpretation of annoyance, as well as the reasonableness of the assumptions on which the probabilistic model of annoyance is built.

Some specific implications of these findings are discussed below.

4.2.1 Implications of Findings for Understanding of Community Response to Noise Exposure

The substantial reduction in the scatter of social survey data that is apparent in Figures 3-2 through 3-7 provides a clear demonstration of the role that response bias plays in self-reports of annoyance. Even more fundamentally, however, the findings of these analyses support a view of the origins of noise-related annoyance that differs considerably from that prevailing for the last several decades. Annoyance need no longer be viewed as a vague "adverse reaction to noise exposure" produced by inadequately understood means. The part of annoyance that is acoustically produced is directly proportional to the loudness and duration of accumulated noise intrusions (at least for noise typical of civilian airports) and may be fully accounted for by a compressive transformation of DNL. The part of annoyance that is not acoustically produced may be influenced by numerous factors, but the aggregate effect of all of these factors may be expressed in terms of a distribution with a specifiable mean ($D^* = 72.95$) and variance ($\sigma = 6.70$).

Basing predictions of the prevalence of annoyance associated with Air Force flight operations on a theoretically-derived dosage-effect relationship permits environmental planners to address long standing problems of data interpretation.

4.2.2 Implications of Findings for Air Force Environmental Planners

The analyses of the previous chapter also have implications for the nature of predictions that Air Force environmental planners may make about the prevalence of annoyance in communities. Current predictions are limited by their reliance on a purely empirical dosage-effect relationship to statements of the following form:

"If reactions to aircraft noise exposure in communities affected by the proposed action are similar to those observed elsewhere, then the percentage of people in these communities who will describe themselves as highly annoyed by the predicted noise exposure is ___."

The following sorts of predictions are permitted by the analyses of the preceding chapter (Fidell and Green, 1988):

"The prevalence in a community of annoyance associated with aircraft noise exposure is determined by both acoustic and nonacoustic factors. In communities that are neither favorably nor unfavorably disposed toward aircraft noise exposure, the prevalence of annoyance associated with noise of the proposed operations would be ___%. This estimate could vary substantially (from ___% to ___%) depending on factors other than the noise produced by the proposed operations. The probability that nonacoustic factors would increase the prevalence of annoyance in the community by as much as ___% is estimated to be ___. The probability that nonacoustic factors would decrease the prevalence of annoyance in the community by as much as ___% is estimated to be ___."

5. Conclusions and Recommendations

5.1 Conclusions

The analyses described in this report demonstrate that the observed prevalence of noise-related annoyance in communities may be partitioned into 2 components, 1 attributable to acoustic factors and 1 attributable to nonacoustic factors. Analyses of data of 34 data sets from 32 different attitudinal surveys involving more than 40,000 interviews demonstrate that this partitioning provides a marked improvement in the ability to predict the prevalence of annoyance in communities.

Analyses of the type described in this report will make it possible for environmental planners to make independent estimates of the relative contributions of these 2 factors to the observed prevalence of annoyance in communities. This in turn will permit them to make more sophisticated predictions and systematic explanations of the annoyance associated with the noise of Air Force flight operations than they can at present.

5.2 Recommendations

The next step to be taken to exploit advances in understanding the bases of community response to aircraft noise exposure is to extend the predictive uses of the probabilistic model. This involves identifying demographic and other characteristics of communities that can be shown to influence the value of the annoyance criterion A. Characteristics of communities in which values of D^* are known from prior social surveys should be determined, and then analyzed to establish associations with D^*. For example, factors such as population densities, economic dependence on noise sources, political interest in noise sources, amounts of media attention, etc., should be subjected to a discriminant function analysis in an effort to predict values of D^*.

It is also recommended that environmental planners be provided with a convenient means for determining the relative contributions of acoustic and nonacoustic factors to the observed prevalence of annoyance in communities, in the form of personal computer software. This software should be designed so that it can eventually be incorporated into the Air Force's Assessment System for Aircraft Noise (ASAN)[5] as an annoyance prediction module. Preparation of this software need not await the availability

[5]ASAN is a geoinformation system and citation database developed by the Air Force for personal computers to assist Air Force environmental planners in performing noise related analyses.

of a production version of ASAN, however; it can be provided to Air Force environmental planners at an earlier date as a standalone program.

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Appendix A
Supporting Calculations

This Appendix contains supporting calculations for the analyses of Chapter 3 of this report in tabular form. One table is shown for the calculations performed on the data of each of the social surveys considered in Chapter 3.

The 3 summary boxes above each table list (from left to right):

Box 1: "Stand Dev. HA" is the standard deviation of the squared differences of the predicted and reported prevalence of high annoyance. "Stand. Dev. L_{dn}" is the standard deviation of the squared differences of the predicted L_{dn} and reported noise level.

Box 2: "A^*_m" is 10 log of the survey averaged annoyance criterion. "A" is the survey averaged annoyance criterion.

Box 3: "D^*_m" represents the survey averaged annoyance criterion expressed in L_{dn} equivalent units. This value has been rounded off to the nearest tenth of a decibel. "N" is the number of interviewing sites that were reported by the survey authors.

Columns 1 and 2: "Reported L_{dn}" and "Reported HA" are the Day Night Average Sound Level and the proportion of respondents describing themselves as highly annoyed, respectively, as reported by the authors of the study and interpreted by Fidell, Barber and Schultz (1989).

Column 3: "Trans. L_{dn}" transforms the reported L_{dn} by subtracting from it D^*_m. This adjustment scales the abscissa by setting the proportion of highly annoyed to 1/e at a value of 0 dB.

Column 4: "Predicted HA" generates a predicted proportion highly annoyed as $P(HA)=e^{-(A/m)}$.

Column 5: "(Rep - Pred HA)^2" represents the squared difference between the reported and predicted proportion of highly annoyed respondents.

Column 6: "Adjusted L_{dn}" is the predicted L_{dn} value associated with a reported prevalence of high annoyance.

Column 7: "(Adj - Reported L_{dn})^2" is the squared difference between the predicted L_{dn} level and the reported L_{dn}.

Column 8: "Estimated A^*_i" is the annoyance criterion required to report high annoyance for a particular survey.

Column 9: "Estimated D^*_i" represents the annoyance criterion expressed in L_{dn}-equivalent [3.33(A^*)] units.

Table A-1: Calculations to Estimate A^* and D^* Values for French Aircraft Survey (Alexandre, 1970).

Stand. Dev. HA = 0.019	$A^*_m = 22.2$	$D^*_m = 74.0$
Stand. Dev. L_{dn} = 1.2	A = 165.9	N = 6

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
52.1	0.020	-21.9	0.011	0.000	54.3	4.630	21.6	71.8
58.1	0.050	-15.9	0.050	0.000	58.1	0.000	22.2	74.0
64.1	0.120	-9.9	0.138	0.000	63.1	0.963	22.5	75.0
70.1	0.260	-3.9	0.270	0.000	69.7	0.172	22.3	74.4
76.1	0.440	2.1	0.421	0.000	76.9	0.568	22.0	73.2
82.1	0.530	8.1	0.565	0.001	80.6	2.325	22.7	75.5

Table A-2: Calculations to Estimate A^* and D^* Values for Second Heathrow Airport Survey (MIL Research, 1971).

Stand. Dev. HA = 0.072	A^*_m = 22.4	D^*_m = 74.7
Stand. Dev. L_{dn} = 4.7	A = 174.7	N = 20

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
45.0	0.010	-29.7	0.000	0.000	52.6	58.323	20.1	67.1
48.0	0.010	-26.7	0.002	0.000	52.6	21.501	21.0	70.1
52.0	0.030	-22.7	0.008	0.000	56.6	20.999	21.0	70.2
56.0	0.020	-18.7	0.026	0.000	55.0	1.003	22.7	75.7
60.0	0.030	-14.7	0.063	0.001	56.6	11.680	23.4	78.2
65.0	0.070	-9.7	0.141	0.005	60.6	19.480	23.7	79.2
69.0	0.190	-5.7	0.226	0.001	67.4	2.554	22.9	76.3
73.0	0.250	-1.7	0.324	0.005	70.0	8.901	23.3	77.7
78.0	0.320	3.3	0.450	0.017	72.9	26.466	24.0	79.9
82.0	0.390	7.3	0.546	0.024	75.6	40.754	24.3	81.1
45.0	0.010	-29.7	0.000	0.000	52.6	58.323	20.1	67.1
48.0	0.020	-26.7	0.002	0.000	55.0	48.978	20.3	67.7
52.0	0.030	-22.7	0.008	0.000	56.6	20.999	21.0	70.2
56.0	0.070	-18.7	0.026	0.002	60.6	21.035	21.0	70.2
60.0	0.070	-14.7	0.063	0.000	60.6	0.344	22.2	74.2
65.0	0.100	-9.7	0.141	0.002	62.7	5.423	23.1	77.1
69.0	0.210	-5.7	0.226	0.000	68.3	0.488	22.6	75.3
73.0	0.280	-1.7	0.324	0.002	71.3	3.058	22.9	76.5
78.0	0.320	3.3	0.450	0.017	72.9	26.466	24.0	79.9
82.0	0.390	7.3	0.546	0.024	75.6	40.754	24.3	81.1

Table A-3: Calculations to Estimate A^* and D^* Values for First Heathrow Airport Survey (McKennell, 1963).

Stand. Dev. HA = 0.080	A^*_m = 21.0	D^*_m = 70.0
Stand. Dev. L_{dn} = 4.3	A = 126.0	N = 10

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
48.0	0.061	-22.0	0.010	0.003	55.1	50.792	18.7	62.9
53.0	0.063	-17.0	0.039	0.001	55.3	5.266	20.3	67.7
54.0	0.142	-16.0	0.049	0.009	60.3	40.118	19.1	63.7
59.0	0.099	-11.0	0.118	0.000	57.9	1.256	21.3	71.1
60.0	0.184	-10.0	0.136	0.002	62.4	5.739	20.3	67.6
65.0	0.158	-5.0	0.243	0.007	61.1	14.836	22.2	73.9
65.0	0.209	-5.0	0.243	0.001	63.5	2.166	21.4	71.5
70.0	0.182	-0.0	0.367	0.034	62.3	59.252	23.3	77.7
71.0	0.320	1.0	0.393	0.005	68.1	8.258	21.7	72.9
76.0	0.489	6.0	0.516	0.001	74.9	1.289	21.3	71.2

Table A-4: Calculations to Estimate A^* and D^* Values for London Traffic Survey (Langdon, 1976).

Stand. Dev. HA = 0.085	A^*_m = 21.5	D^*_m = 71.8
Stand. Dev. L_{dn} = 3.6	A = 142.1	N = 24

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
64.3	0.116	-7.5	0.188	0.005	60.6	13.355	22.6	75.4
65.1	0.308	-6.7	0.205	0.011	69.4	18.384	20.2	67.5
68.0	0.309	-3.8	0.274	0.001	69.4	2.038	21.1	70.3
69.1	0.437	-2.7	0.301	0.019	74.5	29.056	19.9	66.4
69.7	0.310	-2.1	0.316	0.000	69.5	0.054	21.6	72.0
69.7	0.455	-2.1	0.316	0.019	75.2	30.404	19.9	66.2
70.2	0.276	-1.6	0.328	0.003	68.1	4.417	22.2	73.9
70.3	0.277	-1.5	0.331	0.003	68.1	4.670	22.2	73.9
70.4	0.236	-1.4	0.333	0.010	66.4	15.707	22.7	75.7
70.6	0.259	-1.2	0.339	0.006	67.4	10.237	22.5	75.0
70.9	0.220	-0.9	0.346	0.016	65.7	26.528	23.1	76.9
73.4	0.333	1.6	0.410	0.006	70.4	9.119	22.4	74.8
74.2	0.474	2.4	0.430	0.002	76.0	3.191	21.0	70.0
74.4	0.587	2.6	0.435	0.023	80.9	41.878	19.6	65.3
75.2	0.411	3.4	0.455	0.002	73.5	3.043	22.1	73.5
75.9	0.500	4.1	0.472	0.001	77.1	1.347	21.2	70.6
78.4	0.415	6.6	0.532	0.014	73.6	22.905	23.0	76.5
78.6	0.660	6.8	0.536	0.015	84.5	34.441	19.8	65.9
78.8	0.466	7.0	0.541	0.006	75.7	9.860	22.5	74.9
79.2	0.583	7.4	0.550	0.001	80.7	2.210	21.1	70.3
79.2	0.514	7.4	0.550	0.001	77.6	2.405	22.0	73.3
79.6	0.645	7.8	0.559	0.007	83.7	16.721	20.3	67.7

Table A-4: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
80.2	0.545	8.4	0.572	0.001	79.0	1.482	21.9	73.0
80.5	0.544	8.7	0.579	0.001	79.0	2.437	22.0	73.3

Table A-5: Calculations to Estimate A^* and D^* Values for Paris Street Survey (Aubree et al., 1971).

Stand. Dev. HA = 0.035	$A^*_m = 22.3$	$D^*_m = 74.2$
Stand. Dev. L_{dn} = 1.6	A = 168.8	N = 8

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
63.9	0.160	-10.3	0.130	0.001	65.5	2.477	21.8	72.7
66.6	0.130	-7.6	0.184	0.003	64.0	7.182	23.1	76.9
69.4	0.275	-4.8	0.247	0.001	70.5	1.312	21.9	73.1
72.1	0.280	-2.1	0.314	0.001	70.7	1.826	22.7	75.6
74.9	0.440	0.7	0.385	0.003	77.1	4.832	21.6	72.0
77.6	0.430	3.4	0.452	0.001	76.7	0.813	22.5	75.1
80.4	0.500	6.2	0.520	0.000	79.5	0.725	22.5	75.1
83.1	0.600	8.9	0.581	0.000	84.0	0.752	22.0	73.4

Table A-6: Calculations to Estimate A^* and D^* Values for French Rail Survey (Aubree, 1975).

Stand. Dev. HA = 0.036	$A^*_m = 23.4$	$D^*_m = 78.1$
Stand. Dev. $L_{dn} = 2.0$	A = 220.3	N = 5

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre $HA)^2$	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
62.0	0.091	-16.1	0.048	0.002	65.4	11.871	22.4	74.7
66.0	0.086	-12.1	0.100	0.000	65.1	0.796	23.7	79.0
70.0	0.196	-8.1	0.174	0.000	71.0	1.062	23.1	77.1
74.0	0.229	-4.1	0.265	0.001	72.5	2.300	23.9	79.6
78.0	0.313	-0.1	0.365	0.003	75.9	4.275	24.1	80.2

Table A-7: Calculations to Estimate A^* and D^* Values for Swedish Aircraft Survey (Rylander et al., 1972).

Stand. Dev. %HA = 0.085	$A^*_m = 21.8$	$D^*_m = 72.7$
Stand. Dev. $L_{dn} = 6.0$	A = 151.8	N = 17

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
44.5	0.010	-28.2	0.001	0.000	50.6	37.228	20.0	66.6
50.0	0.030	-22.7	0.008	0.000	54.5	20.675	20.4	68.2
52.0	0.060	-20.7	0.015	0.002	57.7	32.893	20.1	67.0
54.0	0.010	-18.7	0.026	0.000	50.6	11.550	22.8	76.1
54.5	0.180	-18.2	0.030	0.023	64.9	108.214	18.7	62.3
54.5	0.070	-18.2	0.030	0.002	58.6	16.410	20.6	68.7
54.5	0.060	-18.2	0.030	0.001	57.7	10.467	20.8	69.5
60.0	0.230	-12.7	0.090	0.020	67.1	50.917	19.7	65.6
60.0	0.030	-12.7	0.090	0.004	54.5	29.735	23.4	78.2
60.5	0.010	-12.2	0.098	0.008	50.6	97.981	24.8	82.6
61.0	0.040	-11.7	0.106	0.004	55.8	27.184	23.4	77.9
62.5	0.080	-10.2	0.132	0.003	59.3	10.261	22.8	75.9
65.5	0.210	-7.2	0.193	0.000	66.3	0.587	21.6	71.9
66.0	0.040	-6.7	0.204	0.027	55.8	104.322	24.9	82.9
70.5	0.390	-2.2	0.312	0.006	73.6	9.491	20.9	69.6
74.0	0.350	1.3	0.401	0.003	72.0	3.977	22.4	74.7
76.5	0.320	3.8	0.463	0.020	70.8	32.262	23.5	78.4

Table A-8: Calculations to Estimate A^* and D^* Values for Swiss Road Survey (Grandjean et al., 1973).

Stand. Dev. HA = 0.025 Stand. Dev. L_{dn} = 2.5	A^*_m = 22.8 A = 188.5	D^*_m = 75.8 N = 6

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
55.0	0.051	-20.8	0.015	0.001	60.1	25.558	21.2	70.8
58.5	0.024	-17.3	0.036	0.000	56.8	2.934	23.3	77.6
62.0	0.048	-13.8	0.074	0.001	59.8	5.002	23.4	78.1
65.0	0.123	-10.8	0.121	0.000	65.1	0.018	22.7	75.7
68.5	0.198	-7.3	0.190	0.000	68.9	0.132	22.6	75.5
72.0	0.233	-3.8	0.271	0.001	70.4	2.569	23.2	77.4

Table A-9: Calculations to Estimate A^* and D^* Values for Swiss Aircraft Survey (Grandjean et al., 1973).

Stand. Dev. HA = 0.111	$A^*_m = 20.3$	$D^*_m = 67.6$
Stand. Dev. L_{dn} = 13.8	A = 106.6	N = 12

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
43.6	0.001	-24.0	0.005	0.000	39.6	15.885	21.5	71.6
47.8	0.010	-19.8	0.020	0.000	45.5	5.363	21.0	69.9
52.0	0.020	-15.6	0.053	0.001	47.8	17.259	21.5	71.7
56.1	0.050	-11.5	0.109	0.004	51.7	19.282	21.6	72.0
60.3	0.090	-7.3	0.191	0.010	54.9	29.477	21.9	73.0
64.5	0.160	-3.1	0.290	0.017	58.8	32.222	22.01	73.3
68.6	0.250	1.0	0.393	0.021	62.9	32.904	22.0	73.3
72.8	0.330	5.2	0.498	0.028	66.1	44.904	22.3	74.3
77.0	0.450	9.4	0.593	0.021	70.9	37.827	22.1	73.7
81.1	0.590	13.5	0.675	0.007	76.8	18.080	21.6	71.8
85.3	0.800	17.7	0.745	0.003	89.3	16.049	19.1	63.6
89.4	0.990	21.8	0.801	0.036	134.2	2005.811	6.8	22.8

Table A-10: Calculations to Estimate A^* and D^* Values for USA 24 Site Survey (Fidell, 1978).

Stand. Dev. HA = 0.077	$A^*_m = 21.6$	$D^*_m = 72.0$
Stand. Dev. $L_{dn} = 4.3$	A = 144.8	N = 24

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
51.1	0.081	-20.9	0.014	0.004	58.7	57.624	19.3	64.4
53.6	0.067	-18.4	0.028	0.002	57.6	16.243	20.4	68.0
54.3	0.041	-17.7	0.033	0.000	55.2	0.834	21.3	71.1
54.8	0.067	-17.2	0.037	0.001	57.6	8.010	20.8	69.2
56.1	0.098	-15.9	0.050	0.002	59.8	13.877	20.5	68.3
56.1	0.103	-15.9	0.050	0.003	60.1	16.310	20.4	68.0
56.6	0.139	-15.4	0.055	0.007	62.2	31.201	19.9	66.4
57.6	0.156	-14.4	0.067	0.008	63.1	29.790	20.0	66.6
59.1	0.081	-12.9	0.087	0.000	58.7	0.173	21.7	72.4
60.2	0.039	-11.8	0.104	0.004	55.0	27.159	23.2	77.2
60.8	0.160	-11.2	0.114	0.002	63.3	6.035	20.9	69.6
61.9	0.095	-10.1	0.134	0.001	59.6	5.141	22.3	74.3
62.3	0.063	-9.7	0.141	0.006	57.3	25.376	23.1	77.1
62.4	0.157	-9.6	0.143	0.000	63.1	0.501	21.4	71.3
62.7	0.236	-9.3	0.149	0.008	66.7	16.058	20.4	68.0
62.7	0.127	-9.3	0.149	0.000	61.5	1.402	22.0	73.2
64.3	0.231	-7.7	0.182	0.002	66.5	4.814	20.9	69.8
64.5	0.153	-7.5	0.186	0.001	62.9	2.536	22.1	73.6
67.3	0.106	-4.7	0.250	0.021	60.3	48.684	23.7	79.0
68.9	0.305	-3.1	0.289	0.000	69.5	0.407	21.4	71.4
69.0	0.111	-3.0	0.292	0.033	60.6	70.174	24.1	80.4
70.6	0.219	-1.4	0.332	0.013	66.0	21.376	23.0	76.6

Table A-10: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
71.7	0.250	-0.3	0.360	0.012	67.3	19.387	22.9	76.4
72.7	0.282	0.7	0.385	0.011	68.6	16.706	22.8	76.1

Table A-11: Calculations to Estimate A^* and D^* Values for Los Angeles Airport Survey (Fidell and Jones, 1975).

Stand. Dev. HA = 0.047	$A^*_m = 22.1$	$D^*_m = 72.0$
Stand. Dev. L_{dn} = 2.1	A = 163.6	N = 2

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
67.0	0.250	-6.8	0.202	0.002	69.1	4.249	21.5	71.7
82.0	0.520	8.2	0.567	0.002	79.9	4.249	22.8	75.9

Table A-12: Calculations to Estimate A^* and D^* Values for Munich Aircraft Survey (Rohrman et al., 1974).

Stand. Dev. HA = 0.149 Stand. Dev. L_{dn} = 9.8	$A^*_m = 21.6$ A = 146.0	$D^*_m = 72.1$ N = 27

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
63.0	0.100	-9.1	0.153	0.003	60.1	8.604	22.5	75.1
63.0	0.050	-9.1	0.153	0.011	56.3	45.465	23.7	78.9
67.0	0.090	-5.1	0.240	0.023	59.4	57.470	23.9	79.7
68.0	0.001	-4.1	0.264	0.069	44.2	568.215	28.8	96.0
73.0	0.210	0.9	0.390	0.032	65.7	53.332	23.8	79.4
73.0	0.070	0.9	0.390	0.102	58.0	225.542	26.1	87.2
74.0	0.380	1.9	0.415	0.001	72.6	1.911	22.1	73.5
74.0	0.300	1.9	0.415	0.013	69.5	20.671	23.0	76.7
75.0	0.500	2.9	0.440	0.004	77.4	5.985	20.9	69.7
75.0	0.500	2.9	0.440	0.004	77.4	5.985	20.9	69.7
76.0	0.250	3.9	0.465	0.046	67.4	73.752	24.2	80.7
77.0	0.570	4.9	0.489	0.007	80.5	12.108	20.6	68.7
78.0	0.410	5.9	0.513	0.011	73.8	17.626	22.9	76.3
79.0	0.750	6.9	0.537	0.046	90.2	124.923	18.3	61.0
79.0	0.750	6.9	0.537	0.046	90.2	124.923	18.3	61.0
79.0	0.500	6.9	0.537	0.001	77.4	2.414	22.1	73.7
80.0	0.570	7.9	0.559	0.000	80.5	0.230	21.5	71.7
81.0	0.770	8.9	0.581	0.036	91.6	111.635	18.5	61.6
85.0	0.840	12.9	0.663	0.031	97.4	154.413	17.9	59.7
86.0	0.650	13.9	0.681	0.001	84.3	2.782	22.1	73.8
87.0	0.760	14.9	0.699	0.004	90.9	14.894	20.5	68.3
87.0	0.630	14.9	0.699	0.005	83.3	13.556	22.7	75.8

Table A-12: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
88.0	0.590	15.9	0.716	0.016	81.4	43.610	23.6	78.7
88.0	0.630	15.9	0.716	0.007	83.3	21.920	23.0	76.8
88.0	0.940	15.9	0.716	0.050	112.4	596.501	14.3	47.7
89.0	0.740	16.9	0.732	0.000	89.5	0.267	21.5	71.6
89.0	0.910	16.9	0.732	0.032	106.3	300.050	16.4	54.8

Table A-13: Calculations to Estimate A^* and D^* Values for U.S. Airbase Survey (Borsky, 1985).

Stand. Dev. HA = 0.131	$A^*_m = 21.5$	$D^*_m = 71.8$
Stand. Dev. L_{dn} = 7.3	A = 142.6	N = 25

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
62.0	0.001	-18.3	0.029	0.001	52.3	94.632	27.0	90.0
62.0	0.087	-18.3	0.029	0.003	67.3	28.367	22.5	74.9
63.4	0.069	-16.9	0.041	0.001	66.0	6.829	23.3	77.6
64.8	0.107	-15.5	0.055	0.003	68.6	14.500	22.9	76.4
65.2	0.074	-15.1	0.059	0.000	66.4	1.433	23.7	79.1
67.1	0.143	-13.2	0.084	0.004	70.6	12.391	23.0	76.7
67.1	0.094	-13.2	0.084	0.000	67.8	0.479	23.9	79.6
67.2	0.001	-13.1	0.085	0.007	52.3	222.841	28.6	95.2
67.8	0.131	-12.5	0.094	0.001	70.0	4.761	23.4	78.1
69.5	0.030	-10.8	0.122	0.009	62.1	54.948	26.3	87.7
69.6	0.192	-10.7	0.124	0.005	73.0	11.548	23.1	76.9
70.3	0.160	-10.0	0.137	0.001	71.5	1.395	23.7	79.1
71.3	0.107	-9.0	0.156	0.002	68.6	7.247	25.0	82.9
71.7	0.172	-8.6	0.164	0.000	72.1	0.133	24.0	79.9
72.6	0.111	-7.7	0.183	0.005	68.9	14.080	25.2	84.0
72.6	0.167	-7.7	0.183	0.000	71.8	0.603	24.3	81.0
72.8	0.139	-7.5	0.188	0.002	70.4	5.710	24.8	82.6
73.0	0.091	-7.3	0.192	0.010	67.6	29.213	25.7	85.7
73.0	0.200	-7.3	0.192	0.000	73.4	0.130	24.0	79.9
73.6	0.175	-6.7	0.205	0.001	72.2	1.940	24.5	81.6
73.7	0.185	-6.6	0.208	0.001	72.7	1.048	24.4	81.3
74.3	0.071	-6.0	0.221	0.023	66.2	66.117	26.5	88.4

Table A-13: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
74.4	0.317	-5.9	0.224	0.009	78.2	14.755	22.9	76.4
74.5	0.122	-5.8	0.226	0.011	69.5	25.164	25.6	85.3
75.0	0.556	-5.3	0.238	0.101	88.0	168.024	20.2	67.3
75.2	0.500	-5.1	0.242	0.066	85.6	107.243	21.0	69.9
75.5	0.286	-4.8	0.249	0.001	77.0	2.248	23.6	78.8
75.5	0.111	-4.8	0.249	0.019	68.8	44.254	26.1	86.9
75.7	0.385	-4.6	0.254	0.017	80.9	27.290	22.5	75.0
76.5	0.380	-3.8	0.274	0.011	80.7	17.868	22.8	76.0
76.0	0.429	-4.3	0.262	0.028	82.7	44.434	22.1	73.6
78.2	0.313	-2.1	0.316	0.000	78.1	0.014	24.1	80.4

Table A-14: Calculations to Estimate A^* and D^* Values for Antwerp Street Survey (Myncke et al. 1977).

Stand. Dev. HA = 0.105	A^*_m = 24.1	D^*_m = 80.3
Stand. Dev. L_{dn} = 5.7	A = 255.6	N = 31

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
51.3	0.062	-20.5	0.016	0.002	57.0	32.534	19.8	66.1
53.5	0.001	-18.3	0.029	0.001	43.8	93.495	24.4	81.5
53.6	0.001	-18.2	0.030	0.001	43.8	95.439	24.5	81.6
55.3	0.281	-16.5	0.044	0.056	68.4	170.441	17.6	58.8
55.5	0.057	-16.3	0.046	0.000	56.6	1.150	21.2	70.7
56.6	0.001	-15.2	0.057	0.003	43.8	163.055	25.4	84.6
60.7	0.250	-11.1	0.116	0.018	67.1	40.705	19.6	65.4
61.3	0.194	-10.5	0.127	0.005	64.6	11.209	20.5	68.5
61.8	0.056	-10.0	0.136	0.006	56.5	28.266	23.1	77.1
61.8	0.029	-10.0	0.136	0.011	53.5	68.780	24.0	80.1
62.4	0.281	-9.4	0.147	0.018	68.4	35.466	19.8	65.9
64.3	0.361	-7.5	0.186	0.030	71.5	52.387	19.4	64.6
65.0	0.351	-6.8	0.202	0.022	71.1	37.750	19.7	65.7
65.6	0.250	-6.2	0.215	0.001	67.1	2.191	21.1	70.3
65.8	0.111	-6.0	0.220	0.012	60.4	29.093	23.2	77.2
67.6	0.178	-4.2	0.263	0.007	63.9	13.635	22.7	75.5
68.0	0.056	-3.8	0.272	0.047	56.5	132.631	25.0	83.3
69.1	0.278	-2.7	0.299	0.000	68.2	0.751	21.8	72.7
69.2	0.333	-2.6	0.302	0.001	70.4	1.523	21.2	70.6
69.7	0.226	-2.1	0.314	0.008	66.1	13.230	22.6	75.4
69.8	0.667	-2.0	0.317	0.122	84.9	227.849	17.0	56.7
71.5	0.531	-0.3	0.360	0.029	78.4	48.006	19.5	64.9

Table A-14: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre $HA)^2$	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
72.1	0.250	0.3	0.375	0.016	67.1	25.200	23.0	76.8
73.6	0.518	1.8	0.413	0.011	77.9	18.255	20.3	67.5
85.4	0.639	13.6	0.676	0.001	83.4	3.851	22.1	73.8

Table A-15: Calculations to Estimate A^* and D^* Values for Brussels Street Survey (Myncke et al., 1977).

Stand. Dev. HA = 0.114	A^*_m = 23.4	D^*_m = 77.9
Stand. Dev. L_{dn} = 7.5	A = 216.9	N = 23

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
66.7	0.001	-11.2	0.115	0.013	49.9	282.342	28.4	94.7
69.3	0.167	-8.6	0.164	0.000	69.4	0.022	23.3	77.7
64.7	0.177	-13.2	0.083	0.009	69.9	27.317	21.8	72.6
70.2	0.261	-7.7	0.183	0.006	73.6	11.581	22.3	74.5
76.2	0.381	-1.7	0.325	0.003	78.4	4.802	22.7	75.7
64.9	0.039	-13.0	0.086	0.002	60.8	16.500	24.6	81.9
75.5	0.533	-2.4	0.308	0.051	84.6	82.467	20.6	68.8
79.2	0.412	1.3	0.402	0.000	79.6	0.172	23.2	77.5
65.3	0.067	-12.6	0.092	0.001	63.5	3.314	23.9	79.7
65.6	0.001	-12.3	0.030	0.001	49.9	246.585	28.1	93.6
72.4	0.385	-5.5	0.232	0.023	78.5	37.808	21.5	71.7
61.5	0.200	-16.4	0.045	0.024	71.0	89.979	20.5	68.4
71.6	0.261	-6.3	0.214	0.002	73.6	4.013	22.8	75.9
75.7	0.167	-2.2	0.313	0.021	69.4	39.083	25.2	84.1
70.2	0.231	-7.7	0.183	0.002	72.3	4.595	22.7	75.7
68.7	0.161	-9.2	0.152	0.000	69.2	0.207	23.2	77.4
77.8	0.440	-0.1	0.366	0.005	80.7	8.588	22.5	74.9
72.0	0.286	-5.9	0.223	0.004	74.6	6.886	22.6	75.3
68.6	0.100	-9.3	0.150	0.002	65.8	7.834	24.2	80.7
77.5	0.708	-0.4	0.358	0.122	93.3	248.625	18.6	62.1
62.6	0.001	-15.3	0.057	0.003	49.9	161.367	27.2	90.6
70.3	0.148	-7.6	0.185	0.001	68.5	3.229	23.9	79.7
62.9	0.059	-15.0	0.060	0.000	62.8	0.007	23.4	78.0

Table A-16: Calculations to Estimate A^* and D^* Values for Burbank Airport Survey (Fidell et al., 1985).

Stand. Dev. HA = 0.261	A^*_m = 17.4	D^*_m = 58.0
Stand. Dev. L_{dn} = 11.4	A = 54.9	N = 20

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
56.0	0.610	-2.0	0.318	0.085	68.2	148.295	13.7	45.8
57.0	0.280	-1.0	0.343	0.004	54.5	6.334	18.1	60.5
57.0	0.710	-1.0	0.343	0.135	73.5	271.885	12.4	41.5
58.0	0.680	0.0	0.368	0.097	71.8	189.621	13.3	44.2
58.0	0.710	0.0	0.368	0.117	73.5	239.907	12.7	42.5
59.0	0.160	1.0	0.394	0.055	49.2	95.875	20.3	67.8
59.0	0.660	1.0	0.394	0.071	70.7	136.679	13.9	46.3
60.0	0.710	2.0	0.419	0.085	73.5	181.951	13.3	44.5
61.0	0.330	3.0	0.444	0.013	56.5	20.395	18.7	62.5
62.0	0.620	4.0	0.469	0.023	68.7	44.380	15.4	51.3
63.0	0.310	5.0	0.493	0.034	55.7	53.440	19.6	65.3
64.0	0.420	6.0	0.517	0.009	60.0	15.722	18.6	61.9
65.0	0.700	7.0	0.540	0.026	72.9	62.433	15.0	50.1
66.0	0.370	8.0	0.563	0.037	58.1	63.033	19.8	65.9
66.0	0.470	8.0	0.563	0.009	62.0	15.640	18.6	61.9
68.0	0.100	10.0	0.606	0.256	45.9	488.262	24.0	80.1
69.0	0.280	11.0	0.627	0.120	54.5	210.734	21.7	72.5
70.0	0.210	12.0	0.647	0.191	51.5	341.004	22.9	76.4
71.0	0.660	13.0	0.666	0.000	70.7	0.095	17.5	58.3
77.0	0.730	19.0	0.764	0.001	74.7	5.228	18.1	60.3

Table A-17: Calculations to Estimate A^* and D^* Values for Canadian Road Survey (Hall and Taylor, 1977).

Stand. Dev. HA = 0.094	$A^*_m = 24.6$	$D^*_m = 81.8$
Stand. Dev. L_{dn} = 5.9	A = 285.3	N = 14

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
57.3	0.045	-24.5	0.004	0.002	65.5	66.603	22.1	73.7
63.0	0.001	-18.8	0.025	0.001	53.9	83.412	27.3	91.0
61.9	0.060	-19.9	0.019	0.002	66.9	24.705	23.1	76.9
64.3	0.080	-17.5	0.035	0.002	68.4	17.074	23.3	77.7
68.0	0.040	-13.8	0.074	0.001	64.9	9.478	25.5	84.9
68.4	0.080	-13.4	0.080	0.000	68.4	0.001	24.5	81.8
69.4	0.260	-12.4	0.094	0.027	77.5	66.127	22.1	73.7
76.0	0.060	-5.8	0.224	0.027	66.9	83.348	27.3	91.0
75.3	0.260	-6.5	0.208	0.003	77.5	4.981	23.9	79.6
74.8	0.170	-7.0	0.197	0.001	73.6	1.530	24.9	83.1
76.0	0.125	-5.8	0.224	0.010	71.2	22.594	26.0	86.6
76.8	0.080	-5.0	0.242	0.026	68.4	70.023	27.1	90.2
83.0	0.445	1.2	0.397	0.002	84.9	3.614	24.0	79.9
84.5	0.580	2.7	0.435	0.021	90.6	37.686	22.7	75.7

Table A-18: Calculations to Estimate A^* and D^* Values for Danish Street Survey (Relster, 1975).

Stand. Dev. HA = 0.122	$A^*_m = 21.4$	$D^*_m = 71.3$
Stand. Dev. $L_{dn} = 6.7$	A = 137.6	N = 28

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
51.0	0.001	-20.3	0.017	0.000	43.3	59.083	23.7	79.0
51.0	0.040	-20.3	0.017	0.001	54.4	11.343	20.4	67.9
51.2	0.114	-20.1	0.018	0.009	60.1	78.600	18.7	62.4
51.3	0.050	-20.0	0.019	0.001	55.4	16.875	20.2	67.2
51.9	0.040	-19.4	0.022	0.000	54.4	6.090	20.6	68.8
54.1	0.001	-17.2	0.038	0.001	43.3	116.350	24.6	82.1
56.5	0.103	-14.8	0.062	0.002	59.4	8.436	20.5	68.4
57.3	0.194	-14.0	0.072	0.015	64.1	46.660	19.3	64.5
57.9	0.117	-13.4	0.080	0.001	60.2	5.475	20.7	69.0
58.3	0.240	-13.0	0.086	0.024	66.1	61.508	19.0	63.4
61.0	0.091	-10.3	0.131	0.002	58.6	5.587	22.1	73.7
61.0	0.102	-10.3	0.131	0.001	59.3	2.747	21.9	72.9
61.4	0.167	-9.9	0.138	0.001	62.9	2.146	20.9	69.8
61.5	0.080	-9.8	0.140	0.004	57.8	13.116	22.5	74.9
67.8	0.472	-3.5	0.280	0.037	75.4	58.385	19.1	63.7
68.1	0.367	-3.2	0.287	0.006	71.3	9.965	20.4	68.1
70.8	0.069	-0.5	0.355	0.082	57.1	188.938	25.5	85.0
71.2	0.245	-0.1	0.366	0.015	66.4	23.490	22.8	76.1
71.2	0.333	-0.1	0.366	0.001	69.9	1.647	21.8	72.6
71.4	0.240	0.1	0.371	0.017	66.1	27.639	23.0	76.5
71.7	0.350	0.4	0.378	0.001	70.6	1.238	21.7	72.4
73.2	0.200	1.9	0.416	0.047	64.4	77.401	24.0	80.1

Table A-18: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
73.7	0.381	2.4	0.429	0.002	71.8	3.581	23.0	73.2
74.1	0.400	2.8	0.439	0.002	72.6	2.381	21.9	72.8
74.4	0.464	3.1	0.446	0.000	75.1	0.511	21.2	70.6
74.4	0.436	3.1	0.446	0.000	74.0	0.171	21.5	71.7
75.1	0.300	3.8	0.464	0.027	68.6	42.196	23.3	77.8
76.1	0.833	4.8	0.488	0.119	95.9	391.975	15.4	51.5

Table A-19: Calculations to Estimate A^* and D^* Values for British Rail Survey (Fields and Walker, 1982).

Stand. Dev. HA = 0.174	$A^*_m = 22.1$	$D^*_m = 73.8$
Stand. Dev. L_{dn} = 10.3	A = 164.0	N = 11

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
29.2	0.001	-44.7	0.000	0.000	45.9	278.900	17.1	57.1
37.3	0.001	-36.5	0.000	0.000	45.9	73.108	19.6	65.3
42.3	0.015	-31.6	0.000	0.000	53.0	115.235	18.9	63.1
47.3	0.014	-26.6	0.002	0.000	52.9	31.702	20.5	68.2
52.1	0.025	-21.7	0.011	0.000	54.9	7.720	21.3	71.1
56.7	0.054	-17.1	0.038	0.000	58.3	2.448	21.7	72.3
61.8	0.089	-12.0	0.101	0.000	61.1	0.553	22.4	74.6
67.0	0.091	-6.8	0.202	0.012	61.2	34.145	23.9	79.7
71.4	0.083	-2.4	0.306	0.050	60.6	115.157	25.4	84.6
76.9	0.259	3.1	0.446	0.035	69.5	55.569	24.4	81.3
82.7	0.096	8.9	0.581	0.236	61.5	448.868	28.5	95.0

Table A-20: Calculations to Estimate A^* and D^* Values for Aircraft/Traffic Comparison Survey [Aircraft Data Only] (Hall et al., 1977).

Stand. Dev. HA = 0.125	A^*_m = 19.0	D^*_m = 63.3
Stand. Dev. L_{dn} = 5.6	A = 79.4	N = 9

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
58.0	0.234	-5.3	0.236	0.000	57.9	0.007	19.0	63.4
60.0	0.293	-3.3	0.284	0.000	60.4	0.124	18.9	63.0
62.0	0.333	-1.3	0.334	0.000	61.9	0.003	19.0	63.4
64.0	0.407	0.7	0.385	0.000	64.9	0.745	18.7	62.5
66.0	0.409	2.7	0.436	0.001	64.9	1.119	19.3	64.4
68.0	0.586	4.7	0.485	0.010	72.4	19.281	17.7	58.9
70.0	0.727	6.7	0.532	0.038	79.9	97.396	16.0	53.5
72.0	0.539	8.7	0.577	0.001	70.3	2.934	19.5	65.0
74.0	0.320	10.7	0.620	0.090	61.4	157.974	22.7	75.9

Table A-21: Calculations to Estimate A^* and D^* Values for Aircraft/Traffic Comparison Survey [Traffic Data Only] (Hall et al., 1977).

Stand. Dev. HA = 0.070	$A^*_m = 21.9$	$D^*_m = 72.9$
Stand. Dev. L_{dn} = 3.4	A = 154.2	N = 12

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
53.0	0.054	-19.9	0.019	0.001	57.4	19.594	20.6	68.5
55.0	0.030	-17.9	0.032	0.000	54.8	0.053	21.9	73.2
57.0	0.083	-15.9	0.049	0.001	59.7	7.469	21.1	70.2
59.0	0.045	-13.9	0.073	0.001	56.5	6.005	22.6	75.4
61.0	0.057	-11.9	0.102	0.002	57.7	10.908	22.9	76.2
63.0	0.086	-9.9	0.137	0.003	59.9	9.358	22.8	76.0
65.0	0.256	-7.9	0.177	0.006	68.5	11.934	20.8	69.5
67.0	0.350	-5.9	0.222	0.016	72.2	27.346	20.3	67.7
69.0	0.231	-3.9	0.269	0.001	67.4	2.554	22.4	74.5
71.0	0.267	-1.9	0.319	0.003	68.9	4.374	22.5	75.0
73.0	0.227	0.1	0.370	0.020	67.2	33.288	23.6	78.7
75.0	0.486	2.1	0.420	0.004	77.7	7.064	21.1	70.3

Table A-22: Calculations to Estimate A^* and D^* Values for Orange County Airport Survey (Fidell et al., 1985).

Stand. Dev. HA = 0.044	$A^*_m = 17.6$	$D^*_m = 58.6$
Stand. Dev. L_{dn} = 1.8	A = 57.4	N = 12

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
58.0	0.410	-0.6	0.352	0.003	60.3	5.204	16.9	56.3
59.0	0.410	0.4	0.378	0.001	60.3	1.642	17.2	57.3
59.0	0.430	0.4	0.378	0.003	61.1	4.310	17.0	56.5
59.0	0.450	0.4	0.378	0.005	61.9	8.281	16.7	55.7
61.0	0.430	2.4	0.428	0.000	61.1	0.006	17.6	58.5
62.0	0.450	3.4	0.453	0.000	61.9	0.015	17.6	58.7
63.0	0.500	4.4	0.478	0.001	63.9	0.858	17.3	57.7
63.0	0.430	4.4	0.478	0.002	61.1	3.702	18.2	60.5
65.0	0.510	6.4	0.525	0.000	64.3	0.428	17.8	59.3
67.0	0.510	8.4	0.571	0.004	64.3	7.045	18.4	61.3
67.0	0.520	8.4	0.571	0.003	64.8	4.976	18.3	60.9
68.0	0.550	9.4	0.593	0.002	66.1	3.735	18.2	60.6

Table A-23: Calculations to Estimate A^* and D^* Values for Austalian Aircraft Survey (Hede and Bullen, 1982).

Stand. Dev. HA = 0.088	$A^*_m = 22.4$	$D^*_m = 74.5$
Stand. Dev. L_{dn} = 5.9	A = 171.9	N = 42

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
53.7	0.042	-20.8	0.015	0.001	57.8	16.620	21.1	70.4
54.7	0.001	-19.8	0.020	0.000	46.5	66.685	24.8	82.7
55.6	0.063	-18.9	0.025	0.001	59.7	17.214	21.1	70.4
56.2	0.001	-18.3	0.029	0.001	46.5	93.433	25.3	84.2
56.7	0.088	-17.8	0.033	0.003	61.6	24.225	20.9	69.6
56.8	0.042	-17.7	0.033	0.000	57.8	0.954	22.1	73.5
57.0	0.144	-17.5	0.035	0.012	64.9	63.028	20.0	66.6
58.0	0.083	-16.5	0.044	0.002	61.3	11.106	21.4	71.2
58.2	0.123	-16.3	0.046	0.006	63.8	31.380	20.7	68.9
59.2	0.152	-15.3	0.056	0.009	65.3	37.618	20.5	68.4
59.6	0.078	-14.9	0.061	0.000	61.0	1.855	21.9	73.2
60.2	0.150	-14.3	0.068	0.007	65.2	25.166	20.8	69.5
60.4	0.163	-14.1	0.071	0.008	65.9	29.878	20.7	69.0
60.5	0.001	-14.0	0.072	0.005	46.5	195.051	26.5	88.5
60.6	0.136	-13.9	0.073	0.004	64.5	15.228	21.2	70.6
61.0	0.044	-13.5	0.079	0.001	58.0	9.177	23.3	77.5
61.0	0.108	-13.5	0.079	0.001	62.9	3.749	21.8	72.6
61.2	0.001	-13.3	0.081	0.006	46.5	215.093	26.8	89.2
61.8	0.152	-12.7	0.090	0.004	65.3	12.484	21.3	71.0
62.6	0.078	-11.9	0.103	0.001	61.0	2.684	22.8	76.2
62.9	0.036	-11.6	0.108	0.005	57.1	33.806	24.1	80.3
62.9	0.042	-11.6	0.108	0.004	57.8	26.248	23.9	79.6

Table A-23: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
62.9	0.063	-11.6	0.108	0.002	59.7	9.929	23.3	77.7
63.0	0.268	-11.5	0.109	0.025	70.5	56.612	20.1	67.0
63.2	0.063	-11.3	0.113	0.003	59.7	11.910	23.4	78.0
64.0	0.125	-10.5	0.127	0.000	63.9	0.007	22.4	74.6
64.0	0.241	-10.5	0.127	0.013	69.4	29.264	20.7	69.1
64.4	0.188	-10.1	0.134	0.003	67.1	7.041	21.6	71.9
65.2	0.071	-9.3	0.149	0.006	60.5	22.455	23.8	79.3
65.9	0.050	-8.6	0.163	0.013	58.6	52.876	24.5	81.8
66.1	0.234	-8.4	0.167	0.005	69.1	9.155	21.4	71.5
67.5	0.459	-7.0	0.197	0.068	78.1	112.797	19.2	63.9
67.6	0.354	-6.9	0.199	0.024	74.0	40.520	20.4	68.1
68.2	0.093	-6.3	0.213	0.014	62.0	38.579	24.2	80.7
68.7	0.167	-5.8	0.224	0.003	66.1	6.913	23.1	77.1
68.7	0.292	-5.8	0.224	0.005	71.5	7.926	21.5	71.7
68.9	0.128	-5.6	0.229	0.010	64.1	23.395	23.8	79.3
71.1	0.185	-3.4	0.282	0.009	66.9	17.478	23.6	78.7
71.4	0.391	-3.1	0.289	0.010	75.4	16.178	21.1	70.5
71.5	0.214	-3.0	0.292	0.006	68.3	10.513	23.3	77.8
72.0	0.425	-2.5	0.304	0.015	76.8	22.661	20.9	69.8
73.3	0.246	-1.2	0.337	0.008	69.6	13.511	23.5	78.2

Table A-24: Calculations to Estimate A^* and D^* Values for Tramway/Traffic Comparison Survey [Tramway Data Only] (Rylander, 1977).

Stand. Dev. HA = 0.071	A^*_m = 23.9	D^*_m = 79.7
Stand. Dev. L_{dn} = 5.0	A = 245.6	N = 6

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
64.2	0.050	-15.5	0.054	0.000	63.8	0.169	24.0	80.1
62.1	0.030	-17.6	0.035	0.000	61.5	0.348	24.1	80.3
69.5	0.230	-10.2	0.133	0.009	74.1	21.149	22.5	75.1
64.2	0.010	-15.5	0.054	0.002	57.6	44.028	25.9	86.3
71.7	0.090	-8.0	0.176	0.007	67.0	22.551	25.3	84.4
62.1	0.140	-17.6	0.035	0.011	69.9	60.620	21.6	71.9

Table A-25: Calculations to Estimate A^* and D^* Values for Tramway/Traffic Comparison Survey [Traffic Data Only] (Rylander, 1977).

Stand. Dev. HA = 0.041	$A^*_m = 26.8$	$D^*_m = 89.4$
Stand. Dev. L_{dn} = 6.1	A = 480.2	N = 6

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
63.1	0.001	-26.2	0.002	0.000	61.4	3.019	27.3	91.1
63.1	0.030	-26.2	0.002	0.001	71.2	65.249	24.4	81.3
70.6	0.010	-18.8	0.026	0.000	67.3	11.008	27.8	92.7
71.7	0.001	-17.7	0.033	0.001	61.4	105.217	29.9	99.6
73.8	0.070	-15.6	0.053	0.000	75.2	2.050	26.4	87.9
73.8	0.140	-15.6	0.053	0.008	79.6	33.680	25.1	83.6

Table A-26: Calculations to Estimate A^* and D^* Values for Decatur Airport Survey (Schomer, 1983).

Stand. Dev. HA = 0.035	$A^*_m = 22.2$	$D^*_m = 74.1$
Stand. Dev. L_{dn} = 1.8	A = 166.9	N = 4

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
55.0	0.020	-19.1	0.024	0.000	54.3	0.441	22.4	74.7
61.0	0.060	-13.1	0.085	0.001	59.1	3.578	22.8	76.0
63.0	0.110	-11.1	0.116	0.000	62.6	0.144	22.3	74.5
66.0	0.240	-8.1	0.174	0.004	68.9	8.610	21.3	71.1

Table A-27: Calculations to Estimate A^* and D^* Values for Swedish Railroad Survey (Sorensen and Hammar, 1983).

Stand. Dev. HA = 1.787	$A^*_m = 22.4$	$D^*_m = 74.6$
Stand. Dev. L_{dn} = 5.3	A = 172.9	N = 15

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
53.6	0.02	-21.0	0.014	0.000	54.9	1.690	22.0	73.3
54.6	0.04	-20.0	0.019	0.000	57.1	6.076	21.6	72.1
54.6	0.07	-20.0	0.019	0.002	60.0	29.378	20.8	69.2
56.0	0.10	-18.6	0.027	0.005	62.2	39.112	20.5	68.3
55.7	0.10	-18.9	0.025	0.006	62.5	46.757	20.3	67.8
61.3	0.04	-13.3	0.082	0.002	57.1	18.013	23.7	78.8
61.3	0.13	-13.3	0.082	0.002	64.0	7.142	21.6	71.9
61.3	0.10	-13.3	0.082	0.000	62.2	0.817	22.1	73.7
64.2	0.12	-10.4	0.129	0.000	63.7	0.238	22.5	75.1
64.4	0.21	-10.2	0.133	0.006	68.2	13.952	21.3	70.9
64.8	0.20	-9.8	0.140	0.004	67.7	8.507	21.5	71.7
66.8	0.17	-7.8	0.179	0.000	66.1	0.473	22.6	75.3
68.3	0.05	-6.3	0.212	0.026	59.0	86.508	25.2	83.9
72.2	0.10	-2.4	0.307	0.042	62.7	90.516	25.2	84.1
80.2	0.30	5.6	0.507	0.043	71.9	68.401	24.9	82.9

Table A-28: Calculations to Estimate A^* and D^* Values for Westchester Airport Survey (Fidell et al., 1985).

Stand. Dev. HA = 0.072	A^*_m = 19.7	D^*_m = 65.5
Stand. Dev. L_{dn} = 3.6	A = 92.4	N = 8

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
55.3	0.228	-10.2	0.132	0.009	59.9	20.803	18.3	61.0
57.7	0.301	-7.8	0.180	0.015	62.9	26.768	18.1	60.3
57.4	0.135	-8.1	0.173	0.001	55.5	3.730	20.2	67.5
55.1	0.157	-10.4	0.128	0.001	56.6	2.260	19.2	64.0
52.9	0.084	-12.6	0.092	0.000	52.4	0.260	19.8	66.0
53.8	0.108	-11.7	0.106	0.000	53.9	0.019	19.6	65.4
57.8	0.065	-7.7	0.182	0.014	51.0	46.727	21.7	72.4
56.1	0.109	-9.4	0.147	0.001	54.0	4.413	20.3	67.6

Table A-29: Calculations to Estimate A^* and D^* Values for Danish Rail Survey (Andersen et al., 1983).

Stand. Dev. HA = 0.150	$A^*_m = 22.3$	$D^*_m = 74.2$
Stand. Dev. L_{dn} = 15.1	A = 168.6	N = 26

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
45.0	0.001	-29.2	0.001	0.000	46.3	1.465	21.9	73.0
48.2	0.001	-26.0	0.002	0.000	46.3	3.920	22.9	76.2
49.3	0.001	-24.9	0.004	0.000	46.3	9.301	23.2	77.3
50.4	0.001	-23.9	0.006	0.000	46.3	16.891	23.5	78.3
52.5	0.085	-21.7	0.011	0.005	61.2	75.288	19.7	65.6
54.6	0.001	-19.6	0.021	0.000	46.3	70.054	24.8	82.6
54.6	0.075	-19.6	0.021	0.003	60.5	33.988	20.5	68.4
55.7	0.025	-18.5	0.027	0.000	55.3	0.128	22.4	74.6
56.8	0.020	-17.5	0.035	0.000	54.5	5.147	22.9	76.5
57.8	0.001	-16.4	0.045	0.002	46.3	133.861	25.7	85.8
58.9	0.060	-15.3	0.056	0.000	59.3	0.140	22.2	73.9
60.0	0.055	-14.3	0.068	0.000	58.8	1.293	22.6	75.4
61.0	0.045	-13.2	0.083	0.001	57.8	10.022	23.2	77.4
62.1	0.045	-12.1	0.099	0.003	57.8	17.942	23.5	78.5
63.1	0.001	-11.1	0.116	0.013	46.3	285.266	27.3	91.1
64.2	0.020	-10.0	0.136	0.013	54.5	94.647	25.2	84.0
65.3	0.295	-9.0	0.156	0.019	71.3	36.847	20.4	68.2
66.3	0.190	-7.9	0.178	0.000	66.9	0.297	22.1	73.7
67.4	0.135	-6.8	0.201	0.004	64.2	10.396	23.2	77.5
68.5	0.105	-5.8	0.226	0.015	62.5	36.069	24.1	80.2
69.5	0.315	-4.7	0.251	0.004	72.1	6.811	21.5	71.6
70.6	0.405	-3.6	0.277	0.016	75.7	25.921	20.7	69.1

Table A-29: continued.

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
71.7	0.001	-2.6	0.303	0.091	46.3	645.659	29.9	99.6
72.7	0.490	-1.5	0.330	0.026	79.1	40.806	20.4	67.8
73.8	0.325	-0.4	0.357	0.001	72.5	1.571	22.6	75.5
74.9	0.990	0.6	0.384	0.367	140.8	4350.992	2.5	8.3

Table A-30: Calculations to Estimate A^* and D^* Values for Vienna Street Survey (Bruckmayer & Lang, 1967).

Stand. Dev. HA = 0.094	$A^*_m = 19.7$	$D^*_m = 65.8$
Stand. Dev. L_{dn} = 7.7	A = 94.1	N = 8

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
44.0	0.0001	-21.8	0.011	0.000	33.6	107.36	22.8	76.1
49.0	0.0001	-16.8	0.041	0.002	33.6	235.97	24.3	81.1
54.0	0.1400	-11.8	0.105	0.001	56.0	3.98	19.1	63.8
59.0	0.3000	-6.8	0.202	0.010	63.1	16.76	18.5	61.7
64.0	0.4700	-1.8	0.323	0.022	69.8	34.21	18.0	59.9
69.0	0.6000	3.2	0.449	0.023	75.5	42.32	17.8	59.3
74.0	0.6800	8.2	0.567	0.013	79.6	31.07	18.1	60.2
79.0	0.7000	13.2	0.669	0.001	80.7	2.91	19.2	64.1

Table A-31: Calculations to Estimate A^* and D^* Values for Tracor Small City Survey (Conner & Patterson, 1972).

Stand. Dev. HA = 0.120	$A^*_m = 23.8$	$D^*_m = 79.2$
Stand. Dev. L_{dn} = 6.9	A = 237.5	N = 10

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
47.5	0.020	-31.7	0.000	0.000	59.4	142.630	20.2	67.2
52.5	0.010	-26.7	0.002	0.000	57.1	20.988	22.4	74.6
57.5	0.070	-21.7	0.011	0.003	65.0	56.713	21.5	71.7
62.5	0.090	-16.7	0.042	0.002	66.5	15.744	22.6	75.2
67.5	0.090	-11.7	0.106	0.000	66.5	1.065	24.1	80.2
72.5	0.110	-6.7	0.204	0.009	67.7	22.776	25.2	84.0
77.5	0.220	-1.7	0.325	0.011	73.2	18.627	25.1	83.5
82.5	0.220	3.3	0.451	0.054	73.2	86.787	26.6	88.5
87.5	0.320	8.3	0.569	0.062	77.3	104.043	26.8	89.4
92.5	0.700	13.3	0.671	0.001	94.1	2.604	23.3	77.6

Table A-32: Calculations to Estimate A^* and D^* Values for Tracor Large City Survey (Patterson & Conner, 1973).

Stand. Dev. HA = 0.087	A^*_m = 21.7	D^*_m = 72.3
Stand. Dev. L_{dn} = 6.1	A = 148.0	N = 11

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
47.5	0.060	-24.8	0.004	0.003	57.4	97.376	18.7	62.5
52.5	0.040	-19.8	0.019	0.000	55.4	8.520	20.8	69.4
57.5	0.230	-14.8	0.062	0.028	66.8	85.902	18.9	63.1
62.5	0.160	-9.8	0.139	0.000	63.6	1.153	21.4	71.3
67.5	0.230	-4.8	0.247	0.000	66.8	0.535	21.9	73.1
72.5	0.440	0.2	0.372	0.005	75.2	7.279	20.9	69.6
77.5	0.510	5.2	0.496	0.000	78.1	0.322	21.5	71.8
82.5	0.580	10.2	0.609	0.001	81.1	1.859	22.1	73.7
87.5	0.490	15.2	0.704	0.046	77.2	105.426	24.8	82.6
92.5	0.670	20.2	0.780	0.012	85.6	47.751	23.8	79.3
97.5	0.750	25.2	0.839	0.008	90.4	50.714	23.8	79.5

Table A-33: Calculations to Estimate A^* and D^* Values for Second Swedish Road Survey (Rylander et al., 1976).

Stand. Dev. HA = 0.064	$A^*_m = 25.0$	$D^*_m = 83.2$
Stand. Dev. $L_{dn} = 4.3$	A = 314.3	N = 11

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep $L_{dn})^2$	Estimat. A^*_i	Estimat. D^*_i
62.9	0.030	-20.3	0.017	0.000	65.1	4.764	24.3	81.1
64.1	0.001	-19.1	0.023	0.001	55.3	78.013	27.6	92.1
64.1	0.010	-19.1	0.023	0.000	61.1	8.778	25.9	86.2
64.1	0.060	-19.1	0.023	0.001	68.3	17.397	23.7	79.1
68.6	0.040	-14.6	0.064	0.001	66.3	5.190	25.7	85.5
70.8	0.090	-12.4	0.094	0.000	70.5	0.076	25.6	83.5
70.8	0.110	-12.4	0.094	0.000	71.8	0.967	24.7	82.3
72.0	0.250	-11.2	0.114	0.019	78.5	42.470	23.0	76.7
73.1	0.250	-10.1	0.133	0.014	78.5	29.342	23.3	77.8
76.5	0.190	-6.7	0.203	0.000	75.9	0.358	25.2	83.8
78.8	0.160	-4.4	0.257	0.009	74.5	18.692	26.3	87.6

Table A-34: Calculations to Estimate A^* and D^* Values for French Expressway Survey (Lamure, 1967).

Stand. Dev. HA = 0.104	$A^*_m = 18.3$	$D^*_m = 61.0$
Stand. Dev. L_{dn} = 7.3	A = 67.7	N = 18

Reported L_{dn}	Reported HA	Trans L_{dn}	Predicted HA	(Rep-Pre HA)^2	Adjusted L_{dn}	(Adj-Rep L_{dn})^2	Estimat. A^*_i	Estimat. D^*_i
55.0	0.260	-6.0	0.220	0.002	56.7	2.888	17.8	59.3
56.5	0.220	-4.5	0.255	0.001	55.0	2.229	18.8	62.5
58.0	0.150	-3.0	0.292	0.020	51.7	39.154	20.2	67.3
59.0	0.125	-2.0	0.317	0.037	50.4	73.715	20.9	69.6
60.5	0.280	-0.5	0.355	0.006	57.5	8.889	19.2	64.0
61.7	0.280	0.7	0.385	0.011	57.5	17.484	19.6	65.2
63.0	0.310	2.0	0.418	0.012	58.7	18.276	19.6	65.3
64.5	0.300	3.5	0.456	0.024	58.3	38.127	20.2	67.2
66.0	0.350	5.0	0.492	0.020	60.3	32.392	20.0	66.7
67.3	0.430	6.3	0.523	0.009	63.5	14.682	19.5	64.8
68.5	0.500	7.5	0.551	0.003	66.3	4.760	19.0	63.2
70.0	0.550	9.0	0.584	0.001	68.5	2.372	18.8	62.6
71.0	0.640	10.0	0.606	0.001	72.7	2.863	17.8	59.3
72.5	0.620	11.5	0.636	0.000	71.7	0.645	18.5	61.8
73.8	0.720	12.8	0.661	0.003	77.1	11.074	17.3	57.7
75.0	0.780	14.0	0.684	0.009	81.2	38.075	16.5	54.8
76.5	0.870	15.5	0.710	0.026	89.6	170.339	14.4	48.0
89.5	0.970	28.5	0.870	0.010	111.6	486.432	11.7	39.0